THE

INSTITUTES OF MEDICINE.

BY

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All are but parts of one stupendous whole,
Whose body Nature is, and God the soul.
POPE.

Theory is only common sense applied to calculation.—LA PLACE.

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THIS WORK

Is respectfully Dedicated

TO THE

MEDICAL PROFESSION OF THE UNITED STATES,

BY THEIR OBEDIENT, HUMBLE SERVANT,

THE AUTHOR.

PREFACE.

The Author of this work has endeavored to keep before him the difficult objects of adapting it to the student in medicine and to the more advanced. For the advantage of the former, therefore, he has aimed at such method as he might command, and such illustration as might not seem irksome to the latter. With a view to the former, also, he has endeavored to indicate the intimate manner in which all the topics embraced in the work are related to each other, and their mutual dependences, by constant references from one part to others; and, what is unusual, the Author has made these connecting references in a prospective as well as retrospective manner. With a view, also, to the same objects, the Author had designed a more copious index; but as the stereotype was completed as long ago as the middle of November, and as the state of his health, and other avocations, have not permitted him to complete the index, in its regular order, beyond the 125th page, he has concluded to print it as it now stands, and to extend it in a future edition. Many subjects, however, throughout the work, are now incidentally carried out in the index; but many of the most important receive only a general reference, excepting as they are related to others which are more amply noticed.

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TABLE OF CONTENTS.

	Page
PRELIMINARY REMARKS	1–15
PHYSIOLOGY	15–412
Composition	23–49
Structure	50–73
Vital Principle and its Properties	73–125
Vital Principle	73–89
Irritability	89–100
Sensibility	100–103
Mobility	103, 104
Vital Affinity	105
Vivification	105
Nervous Power	106–111
General Remarks upon the Philosophy of Life	111–122
The Mind and Instinct, and their Properties	122–125
Functions, Common	125–280
Motion	126–128
Absorption	128–134
Assimilation	134
Distribution	207–217
Appropriation	217–227
Excretion	227–234
Calorification	234–279
Generation	279, 280
Functions, Peculiar	280–362
Sensation	280–283
Sympathy	283–362
Its general relations to the nervous system	284–295
Experiments illustrative of	295–321
Varieties or kinds of	321–335
Laws of, applied pathologically and therapeutically	335–353
In its relation to special tissues and organs	353–362
Relative to the Mental Principle and Instinct	362
Vital Habit	363–372
Age	373–383
Infancy	373–375
Childhood	375, 376
Youth	376–380
Manhood	380, 381
Old Age	382, 383
Temperament, Constitution, Idiosyncrasy	383–391
The Sanguine	386, 387
The Melancholic	387–389
The Choleric	389
The Phlegmatic	389, 390
The Nervous	390
Physiology—*continued.*	
Races of Mankind	391–393
Sex	393, 394
Climate	394–396
Habits and Usages	396, 397
Relations of Organic Beings to External Objects	398–400
Death	401–404
Summary Conclusion in Physiology, or its Unity of Design	405–412
PATHOLOGY	413–540
Remote Causes	414–427
Pathological or Proximate Cause	427–434
Symptoms	434–455
The Pulse	443–448
The Tongue	448–450
Secretions and Excretions	450–455
Morbid Anatomy	456–463
Inflammation	464–489
Description of	464–480
Remote Causes of	480, 481
Pathological Cause of	482–489
Active and Passive	486–489
Fever	489–499
Description of	489–497
Remote Causes of	497–498
Pathological Cause of	498–499
Venous Congestion	500–513
Humoralism	514–540
THERAPEUTICS	541–777
General Consideration of	541–563
Cathartics	563–570
Astringents	570–578
Tonics and Diffusible Stimulants	583–590
Antispasmodics	590–593
Cinchona, and its Alkaloids	593–607
Arsenic	607–612
Iodine	612–620
Ergot	620–628
Emmenagogues	628, 629
Diuretics	630–633
Expectorants	633–642
Counter-irritants	642–660
Remedial Action, its General Philosophy	661–689
The Seton	679–681
Local Sedatives, Warm Poultices, &c.	681–683
Genito-urinary Agents	683–689
Uterine Agents	683–689

	Page
Therapeutics—*continued.*	
Bloodletting	690–777
Leeching	692–698
General Bloodletting	698–702
Cupping	702–703
The Nervous Power in its Relation to the Effects of Loss of Blood	703–711
General and Practical Observations upon	711–777
General Extent of Bloodletting	711–724
In Congestive Fevers	724–732
In the recognized Forms of Inflammation	732–736
In Simple Continued and Simple Intermittent Fever	736–739
In the Cold Stage of Fever	739–741
In Apoplectic Affections	741–747
Experience and Opinions of distinguished Physicians as to Bloodletting in Inflammatory, Congestive, and Febrile Diseases	747–766
In the Diseases of Infancy and Old Age	768–770
Spontaneous Hemorrhage	770–772
Misapplied and Excessive	772–776
General Conclusions as to	776–777

INSTITUTES OF MEDICINE.

PRELIMINARY REMARKS.

"Until it is proved that the forces which, in a living body, interrupt the play of the natural chemical affinities, maintain a proper temperature, and preside over the various actions of organic and animal life, are analogous to those admitted by natural philosophy, we shall act consistently with the principles of that science, by giving distinct names to THESE TWO KINDS OF FORCES, and employing ourselves IN CALCULATING THE DIFFERENT LAWS THEY OBEY."—ANDRAL'S *Pathological Anatomy.* See, also, *Medical and Physiological Commentaries,* vol. i., p. 626–632.

"Our notion of life involves something more than mere reproduction, namely, the idea of an ACTIVE POWER, exercised by virtue of a definite form, and production and generation in a definite form. The production of organs, the co-operation of a system of organs, and their power not only to produce their component parts from the food presented to them, but to generate themselves in their original form and with their properties, *are characters belonging exclusively to organic life,* and constitute a form of reproduction INDEPENDENT OF CHEMICAL POWERS. This VITAL PRINCIPLE is only known to us through the peculiar form of its instruments; that is, through the organs *in which it resides.* Its LAWS must be investigated just as we investigate THOSE OF THE OTHER POWERS WHICH EFFECT MOTION AND CHANGES IN MATTER."—LIEBIG'S *Organic Chemistry applied to Physiology,* p. 355.

"Simple views, whether of health or disease, however ingenious, can seldom be just. They have their origin in the spirit of system, not in the careful study and faithful enumeration of the complicated circumstances which concur in the production of all vital phenomena."—THOMPSON, *on Inflammation.*

1, *a.* SOLIDISM and vitalism will form the basis of these Institutes. If consistent in all their parts, without a violation of facts, it is, *prima facie,* a proof of their foundation in Nature. To show this consistency, and to develop the great principles and laws of organic beings, and erect a substantial fabric of Institutes which shall guide the hand of art, we must ascend, progressively, along the fundamental facts in physiology, pathology, and therapeutics; till, at last, we proceed to convert the great system to practical uses, in the preservation of health, and a just, intelligible, and philosophical application of the materia medica to morbid states of the body.

To render this work, therefore, most practical, and to simplify as far as possible the highest department of knowledge, I shall adopt an analytical method. I have also endeavored to arrange the various topics in their most natural order, or as each successive one may appear to emanate from, or to depend upon, the preceding. The student, therefore, to understand the last, must comprehend all the preceding, and so of each in succession. We have thus a connected link throughout; a difficult achievement, and the more difficult as it is the first effort that has been made to present the natural relations of my whole subject in their just order, to point out the affinities, and to exhibit throughout the important laws and essential foundations of vitalism and solidism, and to maintain throughout a consistency of facts and of laws that shall stamp the whole as the *Philosophy of Medicine.*

In making this claim for the Institutes, I am prepared, as in the case of the *Commentaries,* to invite the most rigid scrutiny. If there be any where a collision in principles or facts, or any contradictions of myself, let them be pointed out. My aim is truth, and I desire

nothing for myself which I do not yield to others. That other imperfections exist there can be no doubt. Many of the original doctrines which appear in this work are presented in various connections in the *Medical and Physiological Commentaries.* The spirit of the Commentaries will pervade the Institutes, as being, in my judgment, the only stable foundation.

1, *b.* In the farther prosecution of this work, it will still be my object to speak of such errors as have usurped the rights or blighted the interests of rational medicine. It is not now the time for a simple expression of facts, of experience, and of philosophical doctrines. The errors which surround them must be also exposed and refuted, or the foe of truth, or the ambitious aspirant, or the lover of indolence, will gain something from an indulgence which they know how to seek and appropriate. Nor is any one better aware of the tendencies of free discussion or unsparing of physiologists, than he who has been most successful in the propagation of error, or who would sooner stifle inquiry into factitious systems. Thus, it is said by Liebig, that

"It is too frequently forgotten by *physiologists* that their duty really is, not to *refute* the experiments of others, *nor to show that they are erroneous*, but to discover truth, and that alone."—LIEBIG'S *Organic Chemistry applied to Physiology, &c.*

Now this obvious sophistry betrays its motive, since it is utterly at variance with the habits of him who would enjoin the fiction upon others. Truth should be, indeed, the ultimate object of pursuit; but the first and most important step toward its attainment is the removal of obstacles that may lie in its way (§ 820). It is allowed, indeed, by one of Liebig's most zealous advocates, the editor of the *London Lancet*, that "*the removal of error claims a place next to the establishment of truth*" (Dec., 1844); and it has grown into a proverb, that "it is more difficult to subdue a prejudice than to build a pyramid."

Although, therefore, the contemplated method must be sometimes argumentative and controversial, it has the advantage of leading more immediately to a knowledge of the truth upon disputed questions, than any other which is not demonstrative. There can be no doubt, indeed, that the "establishment of truth" in medical philosophy can be effected only by a simultaneous refutation of the errors which surround it. The mind will not surrender a favorite doctrine, however false, to the force of truth alone. Even its practical disasters, as we every where witness, are an inadequate demonstration. But, when error and truth are presented in forcible contrast, it is the pride of reason to embrace the latter. What is also important, the reader will have been presented, as in the *Commentaries*, with the great rival doctrines in medicine, and in their proper relations to each other (§ 350½).

2, *a.* The Institutes of Medicine are natural inductions of principles and laws from the healthy and morbid phenomena of living beings. They relate to Physiology, Pathology, and Therapeutics, and to nothing else. All other systems, therefore, must be spurious. The substitutes have no depth, no principle, no laws, and are recommended alone by their naked simplicity. "Gentlemen," says Bacon, "nature is a labyrinth, in which the very haste with which you move will make you lose your way."

2, *b.* The immediate objects of physiology are a critical analysis of

the vital conditions and results of organic beings, as manifested in different organs, and in their relations to each other. It contemplates organic nature, therefore, in its natural state; and the laws which it obeys are its highest end. Pathology is to the physician the great final object of physiology. It investigates the causes which disturb the physiological conditions, and inquires into the phenomena, and the nature of the vital and structural changes. These, in connection, form the ground-work of Therapeutics, which considers the indications to be fulfilled, and the means and the manner by which they are to be accomplished, and nature thus aided in the process of cure. The Materia Medica comes last, and is the subordinate object of all the rest. It investigates the composition and physical character of the material objects by which the therapeutical intentions are fulfilled, and interrogates especially their relations, as vital and alterative agents, to pathological conditions. Disease, being a modification of the physiological or natural condition, produces new relations between the properties of life and the natural, morbific, and remedial agents; and these are ascertained by observation of their effects upon morbid states alone. It is thus that remedies become beneficial when they would be morbific in health; and what is salubrious in health is rendered morbific by diseased conditions. The principle is in beautiful harmony with the instability of the vital properties; and the final cause of this instability is the preservation of organic being (§ 133, *c*, 153–156, 638).

2, *c*. Nevertheless, each of the four great departments of medicine possess so many peculiar characters, that they may be severally considered as constituting, to a large extent, distinct parts of one great symmetrical whole (§ 83, *c*). Pathological conditions could never have been inferred, *à priori*, from any extent of physiological inquiries, nor could the effects of therapeutical agents, or the natural termination of disease in health or in death, from any knowledge of anatomy, physiology, or pathology. The whole is originally the work of observation; and we come to learn the relations of the four great branches of medicine by comparing the phenomena which are presented under the various conditions of health and disease, and as these phenomena may be affected by artificial influences.

Anatomy, however, affords no such standard of comparison. And yet it is obvious, as will more distinctly appear hereafter (§ 83–163), that anatomy is the basis of medicine. It is, however, of the system of organic life that I mainly speak. All, at least, that is superficial in animal life, the voluntary muscles, &c., abstracted from their relations to the organic condition, belongs to the domain of surgery, and is, therefore, of little importance to the physician.

2, *d*. Notwithstanding, therefore, the foregoing qualifications, it will be seen, in our inquiries into the great fundamental points, that the science of medicine is, throughout, a perfectly connected chain; beginning with the laws which govern the modes in which the elements of matter are combined in organic beings,—advancing to the union of organic compounds into cells and tissues,—to the laws which respect the various processes which are conducted by these tissues, and by the organs into which they are combined,—to those laws as affected by the contingencies of disease,—and, lastly, to the laws which regulate the changes through which the morbid states return to

the natural conditions of life. All are connected together by intimate dependencies, and are determined by the natural or by the varying states of the vital properties in their operation through material parts. The ground-work of the whole is, therefore, perfectly simple; since the laws by which the whole is regulated are established upon the constitution of the organic properties (§ 169, *f*, 638).

2, *e*. To the eye of the philosopher, therefore, Nature, in her or ganic department, as in every other, appears in an aspect of astonishing simplicity, when he contrasts her forces and laws with the diversity of their phenomena; nor does he confound the principles and laws which distinguish the different departments of nature. To every other eye the phenomena of life appear confused, and seem referable to no common powers or laws. But he who has obtained the key to the true philosophy of life, by a wide observation of nature, lays open at once the apparent secrets of all its results, whether in health or disease. Whatever he sees has its individuality, and stands in relief from all the rest. He knows at a glance, from whence this or that springs, how it is related to others, and he traces the whole directly up to a few simple principles. To all but such an eye, however, the phenomena of life, and more especially of life diseased, appear as does a field to all but the botanist. The common observer sees nothing but a confused assemblage of grasses, and probably will tell you there is but one species where the botanist will as instantly discover fifty. Each species has to the latter a distinct individuality, and he cannot regard them in that state of confusion which is seen by the ignorant. He has studied each plant, knows its specific characters, its relations to others, its habits, &c. By these modes of observation, he has also acquired the knowledge that nature has pursued a common plan of organization, and linked the whole, by close analogies, throughout the vegetable kingdom. Were the botanist, therefore, to range simultaneously among the 100,000 species of plants, he would see nothing but individuality, and the greatest simplicity in the principles upon which the whole are constituted. And just so it is with a philosophical observation of the healthy and morbid phenomena of the animal kingdom.

3. The organic and inorganic kingdoms have, respectively, their peculiar properties and laws. Such as appertain to life, in its natural, as well as morbid aspects, are denoted by an incomparably greater variety of phenomena than those of the external world; and as their only intelligible foundation is the phenomena evinced, we attain our knowledge of either according to the extent and variety of the phenomena. We know nothing more of matter itself.

Without a comprehensive knowledge of the properties and functions of living beings, and especially of the laws by which they are governed in their healthy and morbid states, the practice of medicine is mere empyricism. The ignorant, alone, undervalue causes and principles, and depend upon unconnected facts.

4, *a*. In medicine, therefore, we must concern ourselves with some thing besides effects. We must understand the laws under which they take place, and, as far as possible, trace up the effects to the primary causes. This is always done in other sciences and in the arts. Why, then, should it be neglected in that science whose practical application relates to the highest welfare of man?

The human mind will have its theories upon all subjects; and the whole history of medicine is a perpetual exemplification, that in no inquiries do theory and hypothesis abound so universally as in the healing art (§ 819–960). This arises, in part, from the intricacies of the subject, but mostly so from the constitution of the mind itself. The Almighty designed it for theoretical conclusions, and set us the example in those stupendous theories upon which the universe, and all it contains, are founded. And what else are, or should be, our inquiries and our theories, than finding out and adopting those of which He is the author? What other theory in the natural world can there be, than such as are instituted by the Almighty Being? And shall we hesitate to embrace, and to act upon such theories? And yet it is one of the pretended improvements of the day to insist upon nothing but facts, and to denounce all principles in medicine; as if the Almighty had not ordained principles and laws as well as facts, which are mere emanations from the former.

4, *b*. The ignorant pretender will tell us that all this is unimportant; though no one is so much directed by hypothesis, or theory, as this very pretender himself (§ 884). Does not every empyric in the land prescribe his drastic cathartics for the purpose of cleansing the blood of its supposed impurities? Are they not exactly on a par, in their doctrines, and in their practice, with the most speculative of our enlightened humoralists? Nay, have the ignorant portion of that sect, our Brandreths, our Morrisons, *et id omne genus*, any reference whatever to facts or experience? Is it not all hypothesis, and, therefore, all a reckless waste of human life? Mount up the scale, and you shall find at every step of your ascent, from him who prowls about the outskirts of the profession, to him who directs the all-potent drug with the most consummate skill, that each and all mainly rely upon their conceptions of the philosophy of disease. But you shall also find, that in proportion as Nature has been taken for their guide, and as medical principles are founded upon the absolute phenomena of life, in their healthy and morbid aspects, *there* will always be the greatest reference to facts and experience.

Hence, again, the importance of looking well to our theories, and of seeing that they are established on well-grounded facts, or on the analogy to which they conduct us. Could we, as we cannot, conduct the treatment of disease without principles, we never should; and it should therefore be the business of the practitioner to enlighten his mind upon the philosophy of medicine, or his unavoidable disposition to theorize may prove a scourge to mankind. Of this, indeed, the records of medicine abound with examples (§ 801, *b*, 819, &c., 960, 1005).

It will therefore be my agreeable task to expose, in these Institutes, the fallacies of the prevailing physical doctrines of life and disease, as well as to inculcate principles which exalt our science above the mere world of matter, render it consistent in all its details, and present it to the profession as a department of knowledge fundamentally distinct from all other pursuits.

Differences of opinion on questions of great moment to mankind are apt to be strongly conveyed, and apparent error to be censured in no measured terms. This, perhaps, is often admissible, considering the obstinacy of error, and so long as it is the doctrine, and not its au-

thor, which is assailed. We may revere the names of Voltaire, of Hume, and of Gibbon, yield them a proud rank in the scale of intellect, and gratefully acknowledge the rich legacies they have left behind. But, who of us would hesitate to speak of their infidelity according to its nature and tendencies? This is even demanded by what we believe of the precepts of religion. And so of the principles of medicine, which hold as high a relation to the temporal interests of man as do the precepts of religion to his spiritual welfare. The highest order of intellect is often devoted to the dissemination of error, and perhaps more frequently in religion and medicine than in any other of the great interests of mankind. This must be fully and firmly met, not only by evidences of the truth, but by an exposure of its perversions and corruptions.

4½, *a*. The physiological world has been lately divided into three schools. One of these sects virtually regards organic nature as a part only of inorganic, endowed with the same properties and governed by the same laws. It maintains, in short, that there is no essential difference between a man and a stone. At the head of this school stands Liebig, the distinguished and able chemist. It is a great and powerful school, but is falling, daily, beneath the weight of its vast errors and corruptions. It is denominated the *chemical school* of medicine.

4½, *b*. Contrasted with this is the school of *vitalism*, which regards organic and inorganic nature as distinct in their most essential attributes. It supposes that each department is governed by properties and laws peculiar to itself. It regards the organic being as fundamentally distinct from the inorganic in its elementary constitution, in the aggregation of its molecules, in the structure of its parts, in its condition as a whole, and in every phenomenon which it evinces. It sees design in every part of the living being—eloquent even in the dry bones of a skeleton; a design peculiar to every part, while all concur together to the common ends of the more universal designs of procuring the means of sustenance, of maintaining life, of perpetuating the species, &c. On the other hand, this school discerns nothing of the nature of design in the constitution, or in the condition of inorganic matter. It sees nothing here but mere *vis inertiæ*, which, however, is supposed by the chemical school to be capable of evolving from simple matter every variety of organization, with all its specific designs, even instinct and reason, while, at the same time, we hear from the depth of materialism, that "organic nature is the mystery of mysteries."

Again, the vitalists, in consideration of the facts now stated, maintain, in the language of Liebig, the great head of the school of mere physics, "the existence of a principle distinct from all other powers of nature, namely, a *vital principle;*" which organizes and governs all living beings, and which is the fundamental cause of all their phenomena in health and disease. I say, in the language of Liebig, "a principle distinct from all other powers of nature;" for this mere chemist, in his conflicts with living nature, concedes the existence of such a principle as at the foundation of all vital phenomena, yet, in the same general manner, and on all specific questions where he had introduced its direct and exclusive agency, he as unequivocally declares that there is no such principle, and that every result of life and disease, even thought itself, are entirely owing to chemical agencies.

His whole system, as set forth in his "Organic Chemistry applied to Physiology," and in his "Animal Chemistry" as applied to Pathology and Therapeutics, is a tissue of similar contradictions, and of the boldest assumptions. Yet, with deep mortification I say it, he has been hailed with an enthusiasm, before unknown in the annals of medicine, as the only true expounder of physiology and of medical philosophy. The world, however, is fast awaking from its spell-bound delusion, and the doctrines of this "reformer" will soon be mingled with the same and more original chimeras which did their part in "the dark ages of science" (§ 350, &c.).

4½, *c.* Finally, the third school, or that of *chemico-vitalism*, endeavors to form, as it were, a bond of union between the schools of pure vitalism, and of pure chemistry; though such an alliance be as unnatural as human brains in a block of granite. The chemico-physiologist makes a compromise with philosophy, and takes for his rule "*in medio tutissimus ibis.*" It is as regardless as the school of pure chemistry of the universal consent with which physiology has been hitherto restricted to the condition, functions, results, and laws of *living beings*, and chemistry to the condition and laws of *dead matter*. This school, therefore, mingles the doctrines of vitalism and chemistry; allotting to the former one half of the phenomena of life, and the other half to the latter. This is the school to which the young student has the greatest chance of becoming the victim; for it is apparently recommended by the conciliatory principle which I have stated in the form of its motto, and by many of the most distinguished members of our profession.

4½, *d.* I have said that it is a remarkable characteristic of the medical school of pure chemistry, that its doctrines are in perfect conflict with each other, as shown in a work (Liebig's "Animal Chemistry") which is assumed as the basis of the chemical philosophy of life—as the great foundation on which the school itself has been erected. And how could it be otherwise, seeing that this school, and this writer, are constantly employed about two subjects which have no affinities; that is to say, the philosophy of life and the philosophy of chemistry? I shall think it of sufficient importance to substantiate the foregoing fact by many proofs in the course of this work; and, as an example of the whole, I shall adduce the contradictory views which are put forth upon the most important principles which lie at the foundation of organic life, and at the basis of medical science. On the very subject of a *vital principle* itself the genius of the school is as flatly contradictory as on the most unimportant doctrine; for at one moment he avows the existence of such a principle "distinct from all other powers of nature," and calls it "the vital principle," which, he says, governs all the processes of living beings (§ 59, 60), and at the next moment he avows that, "in the animal body we recognize, as the ultimate CAUSE OF ALL FORCE, only ONE CAUSE, the *chemical action* which the elements of the food and the oxygen of the air mutually exercise on each other. *The only known ultimate cause of vital force*, either in animals or in plants, is a *chemical process*."

He renders, as will be seen by ensuing quotations (§ 350), what he assumes as an original fundamental cause of life the indispensable source of another cause, which he avows to be equally original and fundamental; and what is yet more indicative of the chaotic state of

the chemical speculations relative to living beings, this author (as I have shown in the Medical and Physiological Commentaries of many others) assumes, at one time, the chemical force to be the sole cause of all vital processes and results, while, at another time, he regards the vital principle as the only power concerned in the same phenomena. It will be gratifying to curiosity, for example, to observe how Liebig entangles his reader, as it respects the physiology of digestion, by making that process to depend on a purely chemical action, and to evolve that vital principle which he as unequivocally declares to be the only power concerned in chymification (§ 350, nos. 2, 17, 48).

5. Chemical and mechanical philosophy, as we have already seen, are strangers to the philosophy of medicine. There is a natural conflict between the subjects of each. They have no relationship, no sympathies, but carry on a perpetual hostility. The organic being is forever converting to its own uses the inorganic, and changing its very nature into its own. The inorganic is fruitless in resistance and in assault, till the former is passive. It then lays waste the fabric by which it had been wrought into a great system of designs, and degrades the whole to its own level. Chemistry, therefore, begins where physiology ends; and physiology begins with organic influences upon the elements of matter, or where chemistry leaves off. No department of medicine has any thing to hope from chemistry beyond its power of analysis.

And yet do the labors of chemists aspire at a substitution of the ever-fluctuating principles of chemical science for all that has been hitherto founded upon the phenomena of life and disease. Their oft-repeated effort to carry a science which is mainly analytical and mechanical into that which is eminently intellectual and overflowing with the most sublime institutions, and distinguished by the most profound principles and laws of nature, and therefore seductive to an ambition which is restif under the practical manipulations of the laboratory, would raise no inquiry as to motive, or end, did not the proper guardians of the science not only abandon their old and rich domain at the very approach of the enemy, but, with most unnatural distrust of self, invite the destroyer (§ 733, *d*).

The late publication of Liebig's "Animal Chemistry" has abundantly proved the truth of what I sufficiently established in the "Medical and Physiological Commentaries," that the recent application of chemistry to physiology and medicine is not a partial, but a complete substitution of that science. In justification of all this, we are now told that the means of investigation, of analysis, and of creation, have received an extension of which our predecessors had no knowledge Such, however, has always been the pretext of chemistry for its invasions upon the science of life. Take, for example, the words of Fourcroy, who wrote more than sixty years ago, and who, like Liebig and his school, attempted to substitute chemistry for physiology, and to rear up a fabric of medicine upon that imaginary foundation; and this, too, in the case of either of the masters, without having ever read a medical book, or having ever prescribed for a disease. The language of Fourcroy is exactly such as we now hear from the lips of Liebig and his followers; who cheerfully allow that nothing flowed from the labors of Fourcroy to illuminate the dark ways of organic life.

So identical are the language, and ambition, and hope or confidence, and the visionary speculations, of the older and recent chemists, that a space may be well assigned to this exposure of chemical pretensions. We read, then, in Fourcroy, what we read in the works of Liebig and his cotemporary chemists. Thus:

"The errors of the chemical physicians of the last century, and the indifference many practitioners of the present time seem to have for chemistry, have produced a disadvantageous opinion in the minds of many persons, *which time alone can remove.* If the *enthusiasm* of those physicians, who cultivated chemistry, *misled them,* it does not follow that any conclusion can be drawn from thence *that may be applied to the present time.* THE EXACTNESS WHICH THE MODERNS have introduced into every part of *experimental philosophy,* ought to remove the apprehensions of such as, for want of acquaintance with the subject, are apt to imagine that chemistry is still the dark, mysterious science it was a century ago." "It is chemistry alone that can throw any light on the composition of the fluids, and the *changes they undergo by the processes that are carried on during life.* We cannot avoid having recourse to this science, in our endeavors to discover the true mechanism of the *animal functions;* the *properties of the fluids* separated by the different viscera; or the *alterations* such fluids undergo." "It will be necessary to enlarge and multiply these researches on subjects of different age, size, and temperament, in various climates and seasons, and to pursue them among the different classes of animals," &c. "We think it equally necessary to examine the *solids,* by chemical methods, as well in the sound as in the diseased state, and *by a comparison* of their properties, endeavor to discover *to which of the fluids* they owe their formation; and this being known, we may proceed to conjecture, in morbific dispositions, the solid or fluid that has suffered a change.

"If it be *thus established* that the theory of medicine is capable of receiving the most essential advantages from chemistry, it is equally certain that *the practice* is no less in need of the same assistance; since both must of necessity accompany each other, and are promoted by the same means." "Nothing can be more evident than that the *choice of aliments,* and of air, cannot be made with any certainty, but in consequence of *chemical researches into the nature of foods,* and the properties of the atmospheric fluid" (§ 18).—FOURCROY'S *Medical Chemistry,* 1782.

I have said, in the Commentaries, that "a prosperous harvest" was promised from Fourcroy's reformation. But, again I reiterate, where is the evidence? since which time, also, chemistry has made greater advances than any other science, has had its unmolested sway, and Fourcroy's example has been followed with a corresponding diligence. Can you point to a solitary instance in which organic chemistry, except in a negative sense, has advanced the science of life or disease? Do not the very chemists of this day incidentally allow the perfectly abortive nature of their science in relation to physiology and medicine? Consult the quotations in section 350, *b*, 1, &c., and $350\frac{1}{4}$–$350\frac{2}{3}$. Or take the affirmations of the distinguished Mülder (§ $350\frac{3}{4}$), which go, with the rest, to establish the truth of my former assertion, that "*chemistry has been a perfect incubus upon medicine; and the time is not distant when it will have proved, by its own showing, its want of*

relation to our subject, if it have not done so already."—Comment., vol. i., p. 586, *note.*)

$5\frac{1}{4}$, *a*. I agree with the chemical physiologist that "facts are stubborn things," and, with the analogy which reposes upon them, are at the foundation of all philosophy; but it does not equally follow that facts are always philosophically or even honestly applied, nor that he who devotes himself to the laboratory is the best qualified to apply his own facts to organic nature. "We can have no very high idea of experiments made by gentlemen," says Hunter, "who, for want of anatomical knowledge, have not been able to pursue their reasoning even beyond the simple experiment itself." Least of all can the chemist be permitted to charge upon the vitalist a neglect of chemical facts; since it is as well by these as by the phenomena of life that the vitalist overthrows the artificial system (§ 350–$350\frac{2}{3}$). Nor let it be forgotten that it is purely by an appeal to certain false analogies, and by a disregard of the phenomena of living beings, that the physical and chemical hypotheses of life and disease have obtained their ascendency (§ 733, *d*).

All our theories and principles in medicine, it cannot be too often reiterated, should rest upon well-ascertained facts. The great difficulties with which truth has had to contend since the restoration of the proper method of observing nature, consists in the mistaken nature of facts, or of false conclusions from admitted facts. What is often assumed to be fact is just otherwise, and, where the premises are sound, they have frequently led to spurious theories (§ $350\frac{1}{2}$–$350\frac{3}{4}$, 433, &c., 493, 823, &c.).

$5\frac{1}{4}$, *b*. The phenomena of nature are the facts about which all philosophy is concerned, and therefore form the substantial ground of all intellectual acquirements. As they relate to organic beings, to their laws, their properties, their functions, whether morbid or healthy, they are to be found in the organic being himself, not in the workshops of the chemist or of the mechanical philosopher. But, even where the mind admits this proposition, if prone to speculation, it too often regards each fact by itself, and rears up hypotheses wrong in themselves, and in conflict with each other. Facts should therefore be compared before they are reduced to theory; or, where they may conflict with acknowledged principles, they should remain in an isolated state till their true nature may be better understood, or till the principles which they appear to contradict may be shown to be erroneous. Should some fact, for example, appear to indicate the dependence of life upon chemical or any other physical forces, the evidence to the contrary is so various and conclusive, that *that* fact must be considered as deficient in some of its elements, which, if known, would readily bring it under a well-established principle in physiology. These absent elements are some other facts which escape our observation; and thus what is truly fact, in an abstract sense, is made the ground-work of important error.

$5\frac{1}{4}$, *c*. It is the peculiar misfortune of science to generalize too hastily; and it often happens that the explosion, or the introduction, of one error, is the parent of many others. It is also astonishingly true that a few phenomena are abstracted from the whole, of which they may be only sequences of the others, and are made the ground of conflicting doctrines, and substitutes for the theories that are insti-

tuted upon the more fundamental facts; and thus a blind disregard of consistency is permitted to prevail, till a most incongruous series of assumptions, as in Liebig's Animal Chemistry, is presented to us as the science which Nature teaches.

Again, there is a proneness of the human mind to admit of no realities but such as make a strong demonstration upon the senses; and hence it is that the physical and chemical philosophers of life prefer the facts of the laboratory to such as are supplied by organic beings. The former are therefore assumed as the foundation for principles and laws in physiology and medicine; and when it is considered how large a proportion of mankind have not the ability to distinguish the true from the false, especially when the latter is set forth in a confident and dogmatic manner, it ceases to be remarkable that what is comparatively simple, and comes plausibly recommended by the tangible and visible attributes of matter, should command their confidence beyond those realities which can be appreciated only by an exercise of the understanding in connection with the revelations of sense, and which form the ground-work of principles of difficult penetration. There are few, indeed, who are capable of reasoning beyond their senses and the facts themselves, and this is equally true of the chemist, both as to the facts of the laboratory and the phenomena of living beings, whenever he attempts an exposition of the properties and laws of a department of nature which lies not within his sphere of investigation. "Truth, whether in or out of fashion, is the measure of knowledge and the business of the understanding. Whatever is beside that, however authorized by consent or recommended by variety, is nothing but ignorance or something worse."

$5\frac{1}{4}$, *d.* It cannot but be conceded, that, as knowledge advances, and the subjects of inquiry become more or less exhausted, ambition is likely to depart from an observation of nature, to seek gratification and renown in artificial expedients. This is becoming a prevailing propensity in medicine; and many have left, and are leaving, the bulwark of knowledge to rear up hypotheses upon distortions of nature, which, for their better success, they dignify by the name of "experimental philosophy."

$5\frac{1}{4}$, *e.* In medicine, at least, there is but one kind of experimental observation, which consists in the simple study of the phenomena of nature. Or, if art be applied to give them a fuller development, the means must be such as shall elicit results conformable to the institutions of nature. But aside from chemistry, it has been the fatality of the physiological department of medicine to have been encumbered with rude experiments, giving the wildest distortions to the features of nature. When we consider the wonderful susceptibility of the properties of life, how readily their actions and results are influenced by natural agents, how a drop of hydrocyanic acid, or of the alcoholic extract of nux vomica, applied to the tongue of an animal, will extinguish life in an instant; or that the same may be done by thrusting a needle into the medulla oblongata; or how concentrated miasma may almost as instantly induce an attack of fever; or how a little excess in eating may bring on an attack of apoplexy as immediately fatal as a blow on the region of the stomach—fatal, perhaps, in either case, as the artillery of the clouds; or how simple irritations of a nerve may be followed by death from tetanus; or how all the veg-

etable and animal poisons, as well as all things else which do not possess natural relations to the properties of life, will variously change those properties and all their results,—when, I say, we consider all these things, we may well imagine the difficulty of imitating nature by the most cautious experiments, or of developing her laws by mutilating the structure of organic beings, or of illustrating those modifications which spring up in disease, by resorting to processes which are foreign to natural influences. Even the greatest experimentalist in modern times, he who has performed more vivisections than any other man, has placed it upon record, that it is one of the most difficult things in physiology to perform an experiment that shall not be liable to objection. Yet no man ever ventured more hastily upon conclusions from such experiments, and none has thrown greater obstacles, in consequence, in the way of physiology and pathology.

5¼, *f.* The limits which restrain the interposition of art are very narrow; and when organic nature is brought under the influence of artificial causes with a proper reference to these limits, the resulting phenomena may form a safe ground of reasoning as to the laws by which organic beings are governed. Much has been accomplished, in this way, as to the physiological connections of the nervous system with organic actions, the part which it takes in the morbid processes, the sympathetic communications which it establishes throughout the organization, and the interpretation which it supplies of the operation of remedial agents. Nevertheless, the most important part of our knowledge upon these great and intricate questions is abundantly supplied by the natural phenomena of life, as manifested under the varying conditions of health and disease. And that this is so, is sufficiently evident from the fact, that but little *practical* information of the foregoing nature has been added, by recent experiments, to what had been known centuries ago. The late experiments, however, upon the nervous system have confirmed what had been deduced from the more natural process of observation, and have developed some useful facts which it might have been impossible to have known by any other method. Such, for example, is the difference of function between the component parts of the spinal nerves; one part being designed for the transmission of sensation and sympathetic influences, the other for the operation of the will and the development of motion. And yet, if analogy were allowed its proper weight in physiological inquiries, as it must be in reality the great basis of medical science,—if there had been less pertinacity as to the necessity of abstract facts for every conclusion, we might have come, by a process of analogy founded upon ultimate facts, to a knowledge of the constitution of the compound nerves. This could have been inferred from their complex functions as evinced by their phenomena, and by associating them with the simple elements of the cerebral nerves, where it is plainly seen that many of the nerves have, individually, a specific function, and whose phenomena are destitute of complexity.

5½, *a.* But the reign of "experimental philosophy" which so lately appeared in the mutilations of animals to discover their natural functions; in the injection of corrosive and putrid substances into the circulatory apparatus of animals to illustrate the pathology of human disease; in the transfusion of remedial agents into the same order of beings, and even into plants, to ascertain the virtues of remedies, their

modus operandi as curative agents, and the right treatment of human maladies, has given place to an "experimental philosophy" in which organic life has no participation. This is the "philosophy" against which the observer of nature is now called upon to contend; fraught with far greater evils than the spurious systems which it has so suddenly surprised and superseded. It is impossible to calculate the mischief which must result to mankind from its unrestrained popularity. Something may be gathered from its former effects when chemistry was young; and something from the progress of error under the fresh spur of Liebig's Animal Chemistry (§ 350–350⅔, 821). We all know how common the enthusiastic belief that this "Reformer" had overthrown all former systems in every department of medicine; and we may take the following editorial passage from the London Lancet as expressing a very common opinion of the profession as to the application of chemistry at the bedside of disease:

"As organic chemistry marches on, the basis of an improved system of medical practice," says the veteran editor, "it will prove imperative that a rigorous examination of the products of the animal frame, the several humors and excretions of the body, should be employed in the investigation of disease. The period approaches when it will be incumbent on us, not perhaps invariably, but still very often, in prescribing,—say, for typhus, or purpura, or any of the numerous varieties of cutaneous affections, that by a chemical analysis, we should first ascertain the constituents and proportions of the proximate elements of the urine, the saliva, the expired breath, the perspired matter, perhaps the blood, the fæces of the patient, *before applying our remedies;* and this process may have to be gone through not once only, but several times in the progress of the malady." "The time is, we repeat it, approaching when the FOUNDATION OF PRACTICE ON THE LAWS OF ORGANIC CHEMISTRY will form the distinction between the enlightened physician and the mere pretender" (§ 851, 863, *e;* 883, *b*).—*London Lancet*, *April* 29, 1843.

5½, *b*. In the foregoing quotation we have essentially what is now extensively denominated "the progress of medical science," and the nature of the doctrines to which these Institutes are opposed. These Institutes will be found mainly, so far as physics are alleged to be concerned, by the side of all the most illustrious physiologists from Hippocrates to us, whose general views are thus summarily expressed by Bichat:

"The organic chemistry of the laboratory," says Bichat, "is the dead anatomy of the fluids, not a physiological chemistry. The physiology of the fluids should be composed of the innumerable variations which they experience according to the different (vital) states of their respective organs." "The instability of the vital powers is the quicksand on which have sunk the calculations of all the physicians of the last hundred years. The habitual variations of the living fluids, dependent on the instability of the powers of life, one would think, should be no less an obstacle to the chemical physicians of the present age."

"Again, had physiology been cultivated by men before physics, I am persuaded that many applications of the former would have been made to the latter. Rivers would have been seen to flow from the tonic action of their banks, crystals to unite from the excitement

which they exercise upon their reciprocal sensibilities, and planets to move because they mutually irritate each other at vast distances. All this would appear unreasonable to us, who think of gravitation only in consideration of these phenomena. And why should we not, in fact, be as ridiculous when we come with this same gravitation, with our chemical affinities and chemical compositions, and with a language established upon their fundamental data, to treat of a science with which they have nothing whatever to do?"—BICHAT'S *General Anatomy and Physiology.*

6. We may now readily perceive the reason why chemistry has undergone changes within a few years, while all that relates essentially to the properties and laws of organic beings may have been long since known. The chemist operates, and makes all his discoveries, through the forces and laws of inorganic matter. These he may carry into his laboratory, turn into his test glasses, or involve in his crucible. He can therefore oblige nature to form the same inorganic compounds as she forms spontaneously. He can then separate the elements again, and again oblige nature to recombine them after their original manner. But, can he do the same thing with organic beings? He cannot form the most simple organic compound—cannot even recombine the elements when they are once separated;—although he has then the necessary elements, and in their exact proportions. The reason is obvious. The chemist has not at his command in this case, as in the other, the necessary powers; or, as the chemist expresses it, "he cannot place them in the same circumstances as Nature does."

It is clear, therefore, that while the laboratory is the proper place for the study of the inorganic kingdom, we must go to the organic being itself to learn the nature of the powers and laws by which it is governed. These, then, are the reasons why the laws of organic beings have been long so much better understood than those of chemistry. Every thing is artificial in the laboratory, so far as experiments are concerned; and, if these be not the right ones, or be imperfectly conducted, they will either fail to represent nature correctly, or will give her a wrong interpretation. Hence the great instability of this science; and yet we are told that every new theory in chemistry is applicable to physiology and medicine.

But, it is quite otherwise with organic beings. Here all the experiments are carried on by Nature herself, and they cannot deceive. The various results and phenomena are seen in the being itself, and can be seen nowhere else. They must, therefore, be the true guide, and the only guide, to the powers and laws by which organic beings are governed. These phenomena, too, are astonishingly multiplied in any given being, and new ones are presented as the being may come under new influences. But, this variety is extended almost to infinity when we consider that every distinct species of plants and animals has its peculiar manifestations of life. It is also true that each one of this endless variety is utterly different from any of the phenomena of the inorganic world. And when we take all the phenomena of organic beings in connection, and find a perfect harmony among the whole, the nature of the proof is so various and immense as to conduct us to a right knowledge of the principles and laws of life in all their aspects.

Now all this variety has been perpetually before the observation of mankind, and always presented to our observation by nature herself. It therefore ceases, I say, to be remarkable that the science of life had so greatly outstripped that of chemistry; and it will probably forever remain better understood; since nature is the experimenter in one case, and man in the other.

PHYSIOLOGY.

7. The sensible world is composed of animate and inanimate beings, which, with their difference in composition and structure, has led to their division into the organic and inorganic or mineral kingdoms.

8. The relations between the two great kingdoms of nature, and their contradistinctions, render a general reference to the inorganic indispensable to our physiological and higher branches of inquiry.

9. Animals and plants, which make up the organic kingdom, are essentially dependent on the inorganic; but the latter kingdom is perfectly independent of the organic.

10. The beginning of organization is in plants, which are the primary source of nourishment to animals.

11. From the foregoing law arises the great fundamental distinction between plants and animals—that the former subsist on the elements of matter, while the latter are nourished by those elements in an organic state. It appears, therefore, that vegetables are more creative than animals (§ 303).

12. All organic substances are compounds of the simple elements of matter. They are combined by the vital powers, while inorganic compounds are produced by chemical forces.

13. As organization begins in vegetables, it is obvious that a decompounded organic substance can be restored to an organic state only by that vegetable kingdom which was created for the specific purpose of organizing the mineral kingdom, for the ultimate final cause of supplying food to animals. The plant reduces, the animal consumes (§ 303).

14, *a*. If an animal compound be decompounded, the reunion of the elements into an animal substance requires the agency of both vegetable and animal organization; and, not only so, but nothing can reproduce any given animal compound but the precise part of the same species of animal which gave origin to the part so decompounded (§ 12).

14, *b*. Owing to this universal law, by which the animal is rendered so perfectly dependent on the vegetable kingdom, the Creator has given a striking perfection to the grand design, in the institution of an invisible world of animalcula for the consumption of that vast proportion of organic matter which is passing through the process of maceration to its elementary state. Thus arrested by these economists of nature, it advances through an ascending series of animals, till, at last, it becomes the food of man.

The foregoing distinction is fundamental in nature; and here, at the very threshold, we are met by a barrier which the chemist and

physical philosopher cannot pass from one side, nor the physiologist from the other.

14, *c*. I may also say, that it is no small proof of a Creator, that the elements of all combinations which are generated by animals and plants are derived from the inorganic kingdom, which will be allowed to be less productive than the organic. And since, especially, no organic being can generate any elementary substance, nor the elements unite, of themselves, into organic compounds, it follows that the whole was created by a Being of greater power. We can go no farther back than the elements of matter. Here the atheist himself pauses in dismay. They proclaim a God, and reason submits to this limit of its powers.

I may also propose another, and perhaps greater proof of the error of spontaneous generation. The kingdoms of nature are governed by inherent powers, and the organic possess powers peculiar to themselves; but the existence of matter, whether organic or inorganic, is also indispensable to their respective forces. These forces, therefore, did not create matter; and since matter cannot create matter, and therefore did not create itself, it follows that its associate powers did not create themselves. Whence it is obvious that some greater Power exists by which the powers of nature were created in union with matter.

These arguments, therefore, may be taken in connection with those which I formerly adduced for the purpose of exposing the fallacy of the doctrine implied by Carpenter, Pritchard, Fletcher, and others, by assuming that the vital properties exist in the elements of matter, and that, therefore, the elements are capable of arranging themselves into organic beings. (See my *Examination of Reviews*, p. 37, and my *Notice of Reviews*.)

15. Exact analyses are readily made of mineral compounds, and the elements may be recombined into the same or other mineral compounds.

The precise analysis of the most simple organic compound, solid or fluid, as fibrin or albumen, is very difficult, and always liable to doubt.

16. In a primary sense, plants subsist upon the atmosphere and what it contains (§ 303); but they immediately derive much of their nourishment from decaying organic substances that are incorporated with the soil. But, before such compounds can be appropriated by plants, they must be resolved into their elementary state. They can be taken into the organization of plants only in the condition of mineral substances; and even then the most simple binary compound must be decompounded before organization can begin. All the recombinations, as constituting parts in the vegetable economy, are essentially unlike any substance in the mineral kingdom.

17. If animal organization resolve an organic compound into a mineral condition, such compound is useless in the animal economy (§ 13, 14). There is never present, therefore, in the animal organization, as a part of, or as a source of supply to that organization, any mineral substance (§ 360). Whatever mutations the materials of supply may undergo, they must always exist in an organic state, or be permanently restored to the mineral kingdom (§ 16).

18, *a*. We learn from the foregoing premises (§ 17), that food does not lose its organic state during the process of digestion; and since it

becomes more and more nearly assimilated to the living solids from the earliest action of the gastric juice, it is evident that chemical agencies have no connection with the transformations to which it is subjected in the alimentary canal (§ 350–376).

18, *b*. Hence, also, the fallacy of attempting, by chemical analysis, to indicate the proper sustenance of man and animals. "*To determine*," says Liebig, "*what substances are capable of affording nourishment, it is only necessary to ascertain the composition of the food, and to compare it with that of the ingredients of the blood.*" He then proceeds to a practical application of this principle by setting forth the chief elements of the blood. The difficult subject, also, of identifying hay with the flesh of animals, and all the vegetable substances which enter the human stomach with the various tissues of the body, is so far disposed of as to require no other interposition between the nutriment and its conversion into living animal compounds than the chemical forces. This chemical doctrine is thus set forth by Liebig:

"*The most recent and exact researches have established as a universal fact, to which nothing yet known is opposed, that the nitrogenized constituents of vegetable food have a composition identical with that of the constituents of the blood.*"—LIEBIG'S *Animal Chemistry.*

18, *c*. And such, too, is a common example not only of the assumptions of this writer, but of that *positive* manner which has inspired such universal confidence (§ 350¼–350½). There are, of course, in nitrogenized vegetable food certain combinations more or less analogous to what are called the constituents of the blood, though never the same, and but comparatively few in many that are appropriate as means of nourishment; nor could it be doubtful that the elements of the flesh and blood of animals subsisting on vegetables must exist in their food. But the identity of *elements* in any given vegetable and animal compounds is very different from identity of *compounds*, and this, too, with every imaginary latitude of the *isomeric* and *polymeric* problems. Nor have any two chemists agreed, as yet, in their analysis of blood, or of any animal compound.

But we have from the laboratory most ample admissions of the groundless nature of the preceding statement. Thus, again, Liebig:

"As far as our researches have gone, it may be laid down as a law, founded on experience, that vegetables produce, in their organism, compounds of proteine; and that out of these compounds of proteine the various tissues and parts of the animal body are developed BY THE VITAL FORCE, *with the aid of the oxygen of the atmosphere and of the elements of water.*

"Now, although it cannot be demonstrated that proteine exists *ready formed* in vegetable and animal products, and although the difference in their properties seems to indicate that their elements are not arranged in the same manner, yet the HYPOTHESIS *of the pre-existence* of proteine, *as a point of departure* in developing and comparing their properties, *is exceedingly convenient. At all events*, it is CERTAIN that the elements of these compounds assume the same arrangement *when acted on by potash at a high temperature*" ! !—LIEBIG'S *Animal Chemistry.*

Nor is this the end of the contradiction; for we also read in the same work, that

"We cannot, indeed, maintain that the animal organism has no

power to form other compounds, for we know that it is capable of producing *an extensive series of compounds, differing in composition from the chief constituents of the blood*" (§ 409, *b*, and 53, *b*).

But, if the foregoing quotations be conclusive of the specific inquiries before us, the following admitted facts not only establish the same conclusions, but prove that chemistry is entirely incompetent to any one of its pretensions as to a *proximate* analysis of the blood, or of other organic compounds, and that it is strictly limited to a mere *elementary* decomposition; while they also concede the existence of a vital principle as an "immaterial" governing power, wholly different from any attribute of inorganic nature, and therefore render it certain in another aspect, that the chemist, from want of this agent, can, at most, only effect the *elementary* analysis of organic compounds. Thus, then, the organic chemist:

"If the problem to be solved by organic chemistry be this, namely, to explain the changes which the food undergoes in the animal body; then it is the business of this science to ascertain what elements must be added, what elements must be separated, in order to effect, or, in general, to render possible, the conversion of a given compound into a second or third; but we cannot expect from it the *synthetic proof of the accuracy of the views entertained, because every thing in the organization goes on* UNDER THE INFLUENCE *of the vital force, an* IMMATERIAL AGENT *which the chemist cannot employ at will*."—LIEBIG'S *Animal Chemistry*.

18, *d*. If we now turn to section 409, *b*, we shall there find that it is in the blood alone that the reputed proximate principles of vegetables are assumed to exist, and that many proximate compounds are allowed by the chemist to be elaborated from the blood, to which there is nothing at all analogous in the vegetable kingdom, or even in the blood itself.

This, then, is the sum of the whole subject: 1st. The chemist has his favorite doctrine of digestion, as an important foothold for materialism, forever present, to be extended as far as the obscurities of the subject will admit, and to borrow an apparent confirmation from these predicated assumptions. The absolute amount of that doctrine is thus expressed by Liebig:

"In the natural state of the digestive process, the food only under goes a change in its state of cohesion, becoming fluid without any other change of properties."—LIEBIG'S *Animal Chemistry*.

2d. Now, the food undergoing no other change "in the digestive process" than that of becoming "fluid," it is the easiest matter to find it all in the blood just as it was taken into the stomach,—vegetable as well as animal; while, in so finding it, a pretended confirmation is set up of the "universal fact, to which nothing yet known is opposed, that the nitrogenized constituents of vegetable food have a composition identical with that of the blood," and *vice versa*. Or, as Liebig also has it, "vegetables produce in their organism *the blood of all animals*" (§ 350, *no*. 76).

But, 3d. We are assured by chemists, that nothing is more difficult of analysis than the blood, even as it respects its elementary composition; while it is well known that the analyses of this fluid are always discrepant. Hence the impracticability of instituting unexceptionable comparisons between even the elementary composition of

blood and the nitrogenized constituents of plants; while the very nature of the chemical influences exerted upon a vital compound of 17 or 18 elements with a view to its analysis, is conclusive of the artificial condition of all the chemical compounds which may be thus formed out of the homogeneous fluid.

Again, 4th. It is finally said that many substances elaborated from the blood are utterly different from any thing discovered in plants, or in the blood itself (§ 409, *b*). Here, the composition of the organic substances being simple, readily leads to an exposure of the assumptions which have taken refuge under the greater difficulties, and obscurities, and disagreements, attending the analysis of the most complex substance known in nature (§ 53).

18, *e*. But we shall see, farther on, that the chemical school maintain, through their principal chief, those doctrines of digestion, to suit other hypotheses in organic chemistry, which are fundamentally opposed to each other, and which I shall now arrange in connection, that the reader may see, at a glance, not only the speculative nature of organic chemistry, but the feebleness of the assumption as to the identity of the blood and the nitrogenized constituents of plants Thus:

A.

"In the natural state of the digestive process, the food *only undergoes a change in its state of cohesion*, becoming fluid without any other change of properties."—LIEBIG'S *Animal Chemistry*.

B.

"The VITAL FORCE CAUSES A DECOMPOSITION of the constituents of food, and destroys the force of attraction which is continually exerted between their molecules. It alters the direction of the CHEMICAL FORCES in such wise, that the ELEMENTS of the constituents of the food arrange themselves in another form, and combine to produce *new compounds*. It FORCES the *new compounds* to assume forms ALTOGETHER DIFFERENT from those which are the result of the attraction of cohesion when acting freely, that is, without resistance."—LIEBIG'S *Animal Chemistry*.

C.

"The most decisive experiments of physiologists have shown that the process of CHYMIFICATION *is independent of the* vital force; that it takes place in virtue of a PURELY CHEMICAL action, EXACTLY SIMILAR to those processes of DECOMPOSITION or transformation which are known as PUTREFACTION, FERMENTATION, or DECAY."—LIEBIG'S *Animal Chemistry*.

It will be therefore seen by the quotations B and C, that the statement is admitted to be a mere assumption; while it necessarily follows, by adopting either of the contradictory statements, B or C, that the vegetable substances undergo a radical change during the process of digestion, and, therefore, that we cannot find those substances in the blood, but their elements, only, in new and peculiar combinations. The differences, indeed, are probably often much greater than between calomel and corrosive sublimate (§ 350¼).

What, also, gives to the whole of this subject its proper interpretation, is the parallel which is drawn by Liebig between the assimilation of the most virulent poisons and the most appropriate food, as set forth in *Section* 350, Nos. 41 and 42. The looseness of the closing sentence of No. 41, abstracted from all the surrounding evidence of hypothesis, is abundantly conclusive of the conjectural nature of the whole of this pretended mathematical demonstration.

There is no difficulty, however, in comprehending the source of the mistake which honest chemists have made in attempting, by

chemical analysis, to indicate the proper sustenance of man and animals. It lies in a wrong conception of the economy of vegetable life, and thence reasoning from a mistaken coincidence of principles, which exist in the two departments of the organic kingdom in a strikingly modified state, to their more analogous results (§ 10, 13–17).

Since, however, plants subsist upon mineral substances, in their elementary state, the chemist may often successfully indicate those inorganic or organic compounds, which will yield to any given species of plant (whose general elementary composition may be known) the elements that go especially to its nutritive economy. But, from a fundamental distinction between plants and animals (§ 11, 13–17), it is obvious that no such thing can be done in relation to the latter. No better practical proof of this can be wanted, than the perfectly indigestible nature of many compounds which contain the requisite elements. Such compounds, upon the chemical philosophy, as I have said, and as admitted by Liebig, include many virulent poisons in the vegetable kingdom, and many inorganic substances whose binary compounds embrace numerous elements. We need not, indeed, go any farther than the recent experiments by Dr. Beaumont upon the varieties of food, as will be subsequently noticed (366), and Magendie's analogous experiments with the food of animals,* to show that the whole of this subject must be left to natural experience.

Nor does it appear to have occurred to the chemical physiologist, in the foregoing inquiries, that the elementary composition of animals is greatly alike, at least in all mammalia. It should follow, therefore, upon the chemical philosophy, that the practical distinctions should not exist between the food of man and animals, but that a common diet should be as universally adapted as atmospheric air. To this conclusion it may be also added, that the same chemical philosophy refers chymification to a purely chemical process; or, in the language of Liebig, "it takes place in virtue of a purely chemical action, exactly similar to those processes of decomposition or transformation which are known as *putrefaction*, *fermentation*, or *decay*."—*Animal Chemistry*, p. 16. And since, therefore, chymification is "independent of the vital force" (*ibid.*), and as chemistry identifies the gastric juice of man and quadrupeds, and even the chyme, it is obvious that chemistry can predicate nothing, upon this subject, of any difference in the vital constitution of man and animals† (§ 409, 350, *d*).

19. In respect to their general structure, inorganic bodies are homogeneous, organic beings heterogeneous. This applies as well to the elementary constituents in their modes of combination as to the compound structure of the whole being. Each particle of a mineral compound is as much a whole as the greater mass, and has the same combination of elements. Each element is as perfect as the compound conditions. Animals have muscles, glands, nerves, vessels, &c., with an endless variety in the elementary combinations in the same individual. All these parts are necessary to make a whole, and depend, mutually, upon each other for their existence. The same

* See Medical and Physiological Commentaries, vol. i., p. 697, &c.

† See my article on the foregoing subject in the Boston Medical and Surgical Journal, December 27, 1843.

general principle is applicable to plants. Nevertheless, apparent exceptions occur in both animated kingdoms, as in parts of many plants and of polypi. But, in these instances, each part possesses essentially the whole apparatus of organic life.

20. Organic beings grow from within by interstitial deposition of molecules derived from the blood or sap, according to the exact nature of each part. Inorganic bodies do not grow, but increase only by a superficial juxtaposition of parts, which may, also, be wholly unlike the original crystal, or other nucleus, in their elements.

In the process of growth and nutrition, the new material is conveyed within from without, and subjected to many specific changes, till it is resolved into one homogeneous fluid. Atmospheric air is also indispensable to all organic beings. There is nothing analogous in the inorganic world; while these, and an endless series of other facts, establish the identity of the organic life of plants and animals.

21. A peculiar action of certain agents upon the whole organism of plants and animals, called *vital stimuli*, entirely unlike the action of chemical agents, is necessary to the growth and existence of organic beings. They are both internal and external, and give rise to all the phenomena in organic life, and maintain the whole in one exact condition; while the action of agents upon inorganic, or on dead organic, substances, does not elicit one of these multifarious phenomena (§ 74½, 188½).

22. Every part of an animal or vegetable is forever distinguished by the same vital phenomena and physical results; and the action of vital stimuli is forever the same on each part, respectively, but, like the vital phenomena and physical results, different in each; the whole being liable to invariable modifications at different stages of life, and according to temperament, and according, also, to every other modifying influence.

23. Unlike inorganic bodies, organic beings require the coexistence of solids and fluids in their composition.

24. All organic beings have the power of generating motion within all their parts. Mineral compounds have no such endowment. If motion take place in their internal constitution, it depends upon influences which have no existence in living beings. Nor is this all; for motion is always generated in living beings by the operation of a power implanted in their constitution, and this power is brought into action by the mind, and by internal and external physical agents.

25. The solids and certain fluids of organic beings act upon each other. But the fluids act only upon the organic properties of the solids, while the solids transmute the most important fluid into their own substance. The stimulant action of the blood upon the organic properties, and the reaction of the solids upon the blood, are designed for a common end. The concurrence of the whole fabric is necessary to these, as to all other, results. There is nothing analogous in the mineral kingdom.

26. When external or internal agents produce motion in organic beings, they do not affect the composition, in the natural state. It is quite otherwise with inorganic or dead organic compounds.

27. Organic beings are perpetually subject to a vital decomposition and removal of old parts, while the old are exactly replaced by new

ones. It is essential to mineral compounds that they remain without change. Any disturbance of their molecules converts them into compounds of a different nature.

While, therefore, inorganic compounds are forever the same, organic beings are subject to an unceasing loss of identity as respects their present component parts.

28. The external forms of plants and animals are variously and greatly contradistinguished from those of inorganic bodies. The condition of one, also, is uniform; that of the other, even when crystalized, is variable.

29. "The only character," says Müller, "that can be possibly compared in organic and inorganic bodies, is the mode in which symmetry is realized in each; that is to say, the character which minerals possess in their state of crystalization." Yet there is not, in this respect, the slightest analogy; since no true organic compound ever approaches the condition of a crystal. Here we may trust the authority of Liebig, who says of the "vital principle of the animal ovum, as well as the seed of a plant," that,

"Entering into a state of motion or activity, it exhibits itself in the production of a series of forms, which, although occasionally bounded by right lines, are yet *widely distinct* from *geometrical* forms, such as we observe in crystalized minerals. This force," he goes on, "is the vital force, vis vitæ, or vitality."

30. The foregoing considerations, each and all (§ 8–29), demonstrate a radical difference between the forces and laws of organic and inorganic beings, and a remarkable modification of such as are common to plants and animals. But, as the institutions of organic life lie at the foundation of medical science, they should be still farther sought in the contradistinctions between the organic and inorganic kingdoms, and in those diversified phenomena which indicate a common but modified government of animals and plants. All organic beings possess in common the most essential conditions of life, though existing in the two great departments of living nature under specific modifications or varieties; not, however, very dissimilar, but intimately connected by a gradation of analogies, as we descend along the chain of either, till we arrive at their more absolute connecting link in the lowest being of one and the other. Other conditions are superadded to the nobler department, which, with the differences of structure and the modifications of their common properties of life, and their modes of subsistence, distinguish the two living kingdoms from each other.

31. Physiology may be divided into, 1st. The composition of organic beings; 2d. Their structure; 3d. Their properties; 4th. Their functions; 5th. Modifications of properties and functions which arise from sex, temperament, climate, habits, age, &c.; 6th. The relations of organic beings to external objects; 7th. Death.

These several topics will be considered with a special view to the great principles which form the Institutes of Medicine.

FIRST DIVISION OF PHYSIOLOGY.

COMPOSITION.

32. The principal object contemplated by this work in ascertaining the facts relative to the *composition* of organic beings is to settle the principles and laws upon which such beings are constituted, by tracing them out in the fundamental conditions of organic matter.

33. Composition is subdivided into ultimate or elementary, and the proximate parts; the latter being compounded of the former.

34. Of the fifty-five known elementary substances, the following seventeen have been found in the composition of plants: carbon, oxygen, hydrogen, nitrogen, potassium, calcium, iron, manganese, phosphorus, sulphur, silicium, magnesium, aluminum, chlorine, sodium, iodine, bromine.

35. The same elements (34), with the addition of fluor, and the probable exception of aluminum, occur in animals. Arsenic is also often found in man.* Although animals are exposed to various sources from which other elements might be derived, they reject every other elementary principle; or, rather, are incapable of their assimilation.

36. The foregoing coincidence in the common nature of the elements of plants and animals supplies no small proof of the peculiar properties and laws of organic beings. Others, however, more striking, lie at the foundation, and form, also, contradistinctions with the inorganic world.

37. Animal and vegetable substances are mostly composed of carbon, oxygen, hydrogen, and nitrogen, four out of the fifty-five elements that go to the formation of inorganic compounds. The main bulk of plants, indeed, such as the cellular and vascular tissues, is probably composed of carbon, hydrogen, and oxygen alone, as the essential elements; though nitrogen is indispensable to many of the products of vegetable organization, and Liebig says it is found in all parts of a plant (§ 62, *f*, *note*). The three or four indispensable elements compose 90 or more parts of 100 of all the soft textures of animals, and of all plants. These are selected, universally, by the vegetable kingdom, as if by instinct. This circumstance increases greatly the force of the conclusion in the foregoing section (§ 36).

38. The elements of mineral compounds are always united in a binary manner; those of organic in a ternary, quaternary, &c., being always intimately blended with each other. This distinction involves an absolute difference in the powers and laws of the two kingdoms.

39. No two elements, therefore, can form a true organic compound. The rare exceptions which have been made by the chemists are not organic substances, nor can they be rendered such by the animal organization. They belong to the mineral kingdom, from which they cannot be elevated but by the properties of vegetable life (§ 14, 16, 17).

All mineral compounds may be resolved into their elements, which are as perfect minerals as when united. Indeed, the most natural condition of a mineral is the state of a simple element.

* Whence come the fluor and the arsenic, unless through plants? (§ 14–18.)

40. What, therefore, is so fundamental in organic beings as expressed in sections 38 and 39, and universally admitted, allows of no introduction of powers, principles, laws, &c., which shall conflict with the powers and laws upon which the simplest organic compound is constituted. In the progress of this work, it will be seen that this position is every where substantiated. Unity and harmony prevail throughout each department of nature, respectively; and while the powers and laws of the organic are as fully contradistinguished from those of the inorganic kingdom as are their physical and all other attributes, we shall find that the former are apparently embarrassed by a great diversity of phenomena as manifested in health and disease, but that, in reality, all the variety goes to the conclusion that the fundamental principles are the same throughout (§ 638, 733, *d*).

41. Again, we may suppose at least some 20,000,000 of distinct organic compounds in the various species of plants, and some 30,000,000 more in the animal kingdom, formed mostly out of four elements (§ 37), while these same elements form scarcely a dozen combinations in the mineral kingdom.

42. The foregoing organic compounds are formed in each individual, respectively, out of one common homogeneous fluid, composed of about seventeen elements.* No chemical hypothesis can interpret this universal characteristic of the organic kingdom; while all the relative facts of inorganic chemistry are totally opposed to this almost endless and undeviating variety of new combinations out of a common fluid, according to the species of animal or plant, and according to the nature of every particular part. If chemical agencies operated, there would be no uniformity in any secreted product at any two successive moments (§ 741, *b*).

It is one of the frequent concessions of the distinguished chemico-vitalist, Müller, that

"The opinion that the component principles of the organs exist in the blood in their perfect state cannot be possibly adopted. The components of most tissues, in fact, present, besides *many modifications* of fibrin, albumen, fat, and ozmazome, *other perfectly peculiar* matters, nothing analogous to which is contained in the blood." "Even the fibrin of muscle cannot be considered identical with the fibrin of the liquor sanguinis."—MÜLLER.

John Hunter also laid down the following doctrine, as expressed by his editor, Mr. Palmer:

"It is highly probable that the different proximate principles of vegetable and animal substances hold different ranks in the scale of organized substances, in the same manner that one animal ranks higher in the scale of organized beings than another."—HUNTER.

And thus Liebig, as a *vitalist*, in opposition to himself, as a *chemist:*

"In that endless series of compounds, which begins with carbonic acid, ammonia, and water, the sources of the nutrition of vegetables, and includes the most complex constituents of the animal brain, there is NO BLANK, NO INTERRUPTION. THE FIRST SUBSTANCE CAPABLE OF AFFORDING NUTRIMENT TO ANIMALS IS THE LAST PRODUCT OF THE CREATIVE ENERGY OF VEGETABLES."—LIEBIG'S *Animal Chemistry*.

* It is now conceded by physiologists, generally, that the chyle, lymph, and blood, are each, severally, as expressed by Wagner, "homogeneous fluids, with certain peculiar corpuscles mixed with them."—*See* WAGNER'S *Elements of Physiology*, p. 250. *London*, 1842.

43. Although it be generally true that it is the wonderful province of organization to elect only four elements from the homogeneous fluid (§ 42) in the formation of organic compounds, yet there are some compounds which embrace a greater number, though unlike the elements of inorganic compounds, in intimate union with each other (§ 38). The blood, indeed, has not less than seventeen or eighteen elements thus united; a circumstance in itself conclusive that other powers than the chemical must preside over the elaboration of the very limited number of elements that go uniformly to the formation of all other organic compounds. And, although the metallic and earthy substances form no part of the essential organs of life, they are yet vitally united with the indispensable organic compounds in particular parts, and are elaborated from the blood or sap by those parts only, and with an astonishingly relative proportion to the other elements, as sulphur by the brain, phosphate of lime by the bones, fluate of lime by the teeth, phosphate of magnesia by wheat, silex by the stem of wheat, and by the skeletons of many poriferi, &c. We shall not regard these substances as accidental, or as introduced by a physical process, but, as contributing a subordinate part with the essential organic elements toward the perfection of an unfathomable system of Designs, whose moving power is only short of the Creative Energy, in being substituted for that Great First Cause, with limitations that chain it to the fulfillment of secondary ends (§ 847).

44. Organic compounds are forever the same, in health, in any given part of any species of being at each stage of existence, but liable to be more or less modified in an exact manner at the several stages (§ 153–159).

And so of disease. The same morbid state of any given part, *cæteris paribus*, always produces the same modifications of the organic compounds of which it may be composed, the same alterations of the secreted fluids, and the same new formations. All this is distinctly seen in the phases of scrofula, in small-pox, cow-pox, lues, measles, hydrophobia, &c.

It is opposed to all facts, that any chemical influences can decompound a fluid composed of seventeen or eighteen elements, not only in the exclusive manner represented in the last section, but according, also to the exact vital constitution or vital modification of each part.

45. Nevertheless (§ 44), the general composition of animals is the same, whether they subsist upon grass, or flesh, or whatever be the nature and variety of the food. So of the chyme, the chyle, and the blood. There is nothing in chemistry that will throw any light upon these coincidences (§ 17, 409).

46. Contrary to what has been seen of the variety of organic compounds out of four simple elements (§ 41), only a few hundred, at most, of distinct inorganic compounds can be formed out of the 55 elements which compose the mineral kingdom (§ 37). Those few compounds, however, make up the great mass of the globe, while the organic are only scattered over its surface. Nor is there a globe in the universe that would not be as worthless as space, did it not administer to the purposes of life.

47. Different combinations of carbon, oxygen, hydrogen, and nitrogen, constitute, mainly, the whole vegetable and animal materia medi-

ca; while their inorganic compounds do not contribute one remedial agent.

48. It is evident that the four principal elements of organic compounds combine not only in different proportions, but so variously, in respect to the proportions, among themselves, as to bewilder the imagination (§ 41). Chemistry can give us no light upon these subjects, but what is purely analytical; while, in respect to their mineral compounds, the same elements unite only in a small number of proportions, upon which chemistry throws its light with a brilliancy that may be said to penetrate the unfathomable recesses of their organic compounds. This fundamental distinction is necessarily conceded; and it were well for science if chemistry did not overstep the limit. But, the chemist shall always speak for himself. Thus Liebig:

"6 eq. *tartaric acid*, by absorbing 6 eq. oxygen from the air, form *grape sugar*, with the separation of 12 eq. carbonic acid. We can explain, in a similar manner, the formation of all the component substances of plants, which contain no nitrogen, whether they are produced from carbonic acid and water, with separation of oxygen, or by the conversion of one substance into the other, by the assimilation of oxygen and separation of carbonic acid. *We do not know in what form the production of these constituents takes place.* In this respect the *representation* of their formation which we have given *must not be received in an absolute sense, it being intended only to render the nature of the process more capable of comprehension.* But, it must not be forgotten, that, IF the conversion of tartaric acid into sugar, in grapes, *be considered a fact*, it must take place under all circumstances *in the same proportions*" !—LIEBIG'S *Organic Chemistry applied to Physiology.*

The reader should never lose sight of the foregoing hypotheses and admissions. They should be ever ready to chasten his credulity as to the chemical interpretation of every organic compound. They stamp the whole "science of organic chemistry," in its synthetical aspects, as one of pretension, and unworthy the confidence of an intelligent mind (§ 350–350$\frac{3}{4}$).

And this is farther confirmed by the statements in the two next following sections.

49. "The particles of matter," says Liebig, "called equivalents in chemistry, are not infinitely small, for they possess a weight, and are capable of arranging themselves in the most various ways, and of thus forming innumerable compound atoms. The properties of these compound atoms differ in organic nature, not only according to the form, but, also, in many instances, according to the direction and place which the simple atoms take in the compound molecules.

"When we compare the composition of organic compounds with inorganic, we are quite amazed at the existence of combinations in one single molecule, of which ninety or several hundred atoms or equivalents are united. Thus, the compound atom of an organic acid of very simple composition, acetic acid, for example, contains 12 equivalents of simple elements; 1 atom of kinovic acid contains 33; 1 of sugar, 36; 1 of amygdalin, 90; 1 of stearic acid, 138 equivalents. The component parts of *animal* bodies are *infinitely more complex* even than these."—LIEBIG'S *Organic Chemistry*, &c.

50. "Inorganic compounds differ from organic in as great a degree

in their other characters as in their simplicity of constitution. Thus, the decomposition of a compound atom of sulphate of potash is aided by numerous causes, such as the power of cohesion, or the capability of its constituents to form solid, insoluble, or, at certain temperatures, volatile compounds with the body brought into contact with it; and, nevertheless, a vast number of other substances produce in it not the slightest change. Now in the decomposition of a complex organic atom *there is nothing similar to this*."—LIEBIG'S *Organic Chemistry*, &c.

51. "An essential distinction between organic and inorganic compounds is, that in organic products the combining proportions of their elements do not observe, as in mineral compounds, a simple arithmetical ratio."

52. An interesting corollary flows from the foregoing facts (§ 22, 41–50), namely, that all animal and vegetable poisons, all remedial agents of an organic nature, and all the varieties of food, depend upon the modes and proportions in which three or four simple elements unite with each other. It is evident, also, from § 41, that no two remedial agents generated by different species of plants or animals, however analogous, can be exactly alike in their morbific or remedial virtues. Hence the differences among cathartics, emetics, &c. As composition, especially of the sap, also varies more or less at the different ages of plants and at different seasons, and also from unhealthy conditions, so will corresponding differences arise in their remedial and morbific virtues. In all the cases, however, the characteristics of organic products as vital agents are uniformly the same under any given condition of the organic being; and so of each simple element, and of the physiological effects of all vital agents (§ 188½, *d*). The precise natural or morbid states of the organic properties lie at the bottom of the whole philosophy, since these properties, through their instruments of action, combine the elements exactly according to their existing state (§ 650, 826, *f*).

53, *a*. From the facts now stated (§ 38–51), it is evident that the organic chemist can do no more than effect an analysis of organic compounds. He can only present each simple element by itself, without the possibility of acquiring a knowledge of the modes and proportions in which they combine with each other.

53, *b*. So, also, if the aggregate compounds, such as blood, sap, muscle, gastric juice, &c., be, in reality, made up of mere simple compounds, or "proximate principles," by the union of compound atoms, chemistry can give us no information as to the conditions in which they naturally exist. Those combinations which are most alike are different from each other in every distinct part of the organic being, and different in the same parts of distinct species. This is so from the first development of the germ; and what is then begun is perpetuated through the life of the individual, and transmitted to all succeeding generations (§ 63–81, 155). The differences, as we have seen, result from the different proportions in which some three or four simple elements are united together, and from the proportions of different compound atoms which may enter into the entire combination, and from the manner in which they and their elements are combined among themselves. It must be obvious, therefore, that we can never reach the secret of these combinations. We should neces-

sarily expect, even from the shades of elementary distinctions, that chemistry would confound and even identify many compounds that are totally unlike in their nature. And this it actually does, in presenting to us sugar, vinegar, starch, gum-arabic, wood, &c., as the same substance; and in identifying pus and cheese, and, again, the albumen of eggs, lymph, mucus, and the product of certain cancerous affections. Nor is there generally any agreement among the chemists in their analyses of organic compounds. It is as true now, as when Bostock (a chemical physiologist) affirmed, that "every subsequent attempt to discover the *elements* of organized substances differs more or less from those that preceded it."

The moment chemical agencies begin their operation, artificial transformations necessarily ensue, and the nature of the organic compound is changed in a corresponding manner. A large proportion of the resulting products are perfectly new formations, particularly all the binary compounds (§ 38, 39). Nor can there be any doubt that the reputed "proximate principles" are intimately incorporated in any given compound, and have no such separate existence as chemistry teaches. It lies at the very basis of chemistry, that all the elaborations are the artificial results of affinities which have been set in motion by the agents employed, and which are employed for that very purpose. This I have already endeavored to demonstrate in the *Medical and Physiological Commentaries* (vol. i., p. 674–682), even so far as to show that urea may not be formed by the kidneys, but is the result of spontaneous changes after the elaboration of urine, as it is of artificial influences (§ 54, *a*). But, attentive observation will generally detect the chemist in the admission of facts which are subversive of his speculative doctrines (§ 18, 350); and so it is in the case before us. The admission covers the whole ground as to the pretensions of organic chemistry beyond the most simple elementary analysis. Thus,

53, *c*. "Were we able to produce taurine and ammonia directly out of uric acid or allantoine, this might perhaps be considered as an additional proof of the share which has been ascribed to these compounds in the production of bile. It cannot, however, be viewed as any objection to the views above developed on the subject, that with the means we possess, we have not yet succeeded in effecting these transformations out of the body. Such an objection loses all its force, when we consider that we cannot admit, as proved, *the pre-existence of taurine and ammonia in the bile; nay*, that IT IS NOT EVEN PROBABLE that those compounds, which are only known to us AS THE PRODUCTS OF THE DECOMPOSITION OF THE BILE, *exist ready formed, as ingredients of that fluid.* By the action of muriatic acid on bile, we, in a manner, FORCE ITS ELEMENTS TO UNITE IN SUCH FORMS as are no longer capable of change under the influence of the same re-agent." —LIEBIG'S *Animal Chemistry.*

By the admissions, also, in § 18, 42, and 350, it will be seen that the Utopian nature of organic chemistry is equally established in all its pretensions by its own founders and advocates.

54, *a*. Organic substances alone undergo fermentation and putrefaction; and this shows us, also, in the language of Tiedemann, that "even when the life of organic bodies is extinct, we should consider the qualities which they possess, from the time of death to the com-

plete resolution of organization, as the result of the vital powers which have been active in them."

This obvious principle conducts us at once to the whole philosophy of those numerous transformations of which organic compounds are susceptible from chemical agencies, while they still retain their elementary combinations, and appear under uniform aspects when subjected to the same chemical influences, and often analogous to the natural condition of the compound. "It is the power of formation," says Tiedemann, "which, after the extinction of the individual life of organized bodies, renders the organic matters, separated from their organization, capable, provided they have not been reduced to their elements by external physical or chemical actions, of assuming new and more simple forms, according to the diversity of external influences, such as heat, light, water, &c., which determine them in taking on this new form. This power appears, therefore, to be a property inherent in organic matters in general, rendering them able to take other more simple configurations when detached from the combinations of living bodies."

Some organic compounds undergo transformations of the foregoing nature as soon as separated from the organic being. The homogeneous blood is immediately reduced into three principal compounds, which have no natural existence as such. Nor is this all; for there is a fundamental change among the elements and the compound atoms of the entire mass. The changes arise from the loss of the vital properties, and the subsequent operation of chemical influences. Such, too, is the constitution of organic compounds, that there may be a remarkable uniformity in the resulting products when the same chemical agents operate upon any given compound; as exemplified in the various transformations to which sugar is liable, and as seen in the uniform production of morphia, narcotina, quinia, cinchonia, &c.

54, *b*. It is obvious, however, from the premises which I have set forth, that chemistry can, at most, present but a few compounds as apparently distinct from each other in their elementary composition; for, although there are many millions of these distinct combinations in organic beings (§ 41), they commonly possess such analogies that chemistry is obliged to confound all but a few which have strong characteristics. These few, which are denominated *proximate principles*, are supposed by the chemist to make up the entire composition of organic beings. But, a greater proportion even of these few are so inscrutably different from each other in their elementary combinations, that they are classed under common denominations, not only for the foregoing reason, but on account of certain resemblances in their physical properties; while it is by these last, and by their differences in results as vital agents, we come to know that broad distinctions may exist among them. Such, for example, are the various acids, oils, resins, &c.

55. All organic substances, while endowed with life, resist the decomposing influences of all surrounding agents. All inorganic compounds yield to these influences.

56. As soon as organic beings are dead, the very agents that had contributed to their growth and nourishment, now become the causes of breaking up their elementary combinations, and with a rapidity unknown in the ordinary decomposition of mineral compounds. In the

former case, it is allowed by Liebig, that the "VITAL PRINCIPLE OPPOSES to the continual action of the atmosphere, moisture, and temperature, upon the organism, a resistance which is in a certain degree *invincible.*"

57. In the seed and ovum the properties of life are in a state of action which maintains their elementary combinations against the chemical forces. They resist degrees of cold which operate destructively upon their composition when their life is extinct. Those agents, too, as heat and moisture, which speedily resolve the egg and seed, when deprived of life, into their ultimate elements, will in the same degrees of intensity develop from the germ, when alive, a perfectly organized being. In the former case the operation of the principle of life is generally mistaken for "*a force in a state of rest.*" Thus, Liebig:

"In the animal ovum, as well as in the seed of a plant, we recognize A CERTAIN REMARKABLE FORCE, the SOURCE of growth, &c., *a force in a state of rest.*"—LIEBIG'S *Animal Chemistry, first sentence.* See, also, my *Examination of Reviews*, p. 7–28.

58. It follows, therefore, that the power which resists the decomposing forces and agents in living beings combined the elements of such beings, and that death is an extinction of that power. The chemical forces can have no connection with the combinations, since they are held together by a power in direct opposition to chemical influences.

What, therefore, unites the elements and maintains them against the action of chemical agents, being the fundamental power, must necessarily preside over all the processes and results to which organic beings are liable.

59. "The elements of dead organic matter," says Liebig, in his Organic Chemistry, "seem merely to retain *passively* the position and condition in which they had been placed." "The atoms exist only by the *vis inertiæ* of their elements." So, also, Mülder, § 350$\frac{3}{4}$, *m*, and other chemical physiologists. This shows that the original union is effected by other powers than the chemical, which, otherwise, would still operate after death, and prevent decomposition. We also thus learn why dead organic compounds so readily undergo fermentation and putrefaction, and from the slightest influences. All of which, indeed, appears to be abundantly conceded by the chemical philosopher, when he yields to the force of facts. For what can be more ample than Liebig's affirmation, that

"The VITAL FORCE is manifested in the form of RESISTANCE, inasmuch as by its presence in the living tissues, THEIR ELEMENTS *acquire the power of withstanding the disturbance and change in their form and* COMPOSITION, *which external agents tend to produce; a power, which, as chemical compounds, they do not possess.*"—LIEBIG'S *Animal Chemistry.*

And yet again may I press into the service of truth the organic chemist, when he temporarily loses sight of the laboratory, and contradicts those speculations which impart to his writings the zest of novelty. In his *Lectures* for the winter of 1844, Liebig appears to have been alarmed for the safety of his empire, and we have here an unusual amount of "*vitality.*"

The work on *Animal Chemistry applied to Pathology and Thera-*

peutics was more of a distillation from the laboratory than its predecessor, *Organic Chemistry applied to Physiology;* and, as many of the most eminent physiologists in Europe, who were inclined to mingle chemistry with vitalism, were nauseated by the dose which was last administered, Liebig came out in his *Lectures* with the following placebo for the vitalists, and the chemico-vitalists. Were it not contradicted by the lecturer, it should place him in the very front rank of vitalism. The doctrines are of the most fundamental nature, and lie at the basis of these Institutes, and of my "Medical and Physiological Commentaries." It will be seen that they are strictly relative to my present subject, and inculcate all that the most transcendental vitalist can desire as to the *distinct nature of the vital principle, its full control over the processes of life, its extinction at death, and an absolute distinction between vital and chemical processes and results, while those processes and results are, respectively, referred to forces of a totally distinct nature.* Thus:

"After the EXTINCTION of the vital principle," says Liebig, "in organic atoms, they maintain their form and properties, the state into which they have been brought in living organisms, *only by reason of their inherent inertia.* It is a great and comprehensive law of matter, that its particles possess no self-activity, no inherent power of originating motion, when at rest; motion must be imparted by some external cause; and, in like manner, motion once imparted to a body can only be arrested by external resistance.

"The constituents of vegetable and animal substances having been formed under the guidance and power of *the vital principle,* it is this principle which determines the direction of their molecular attraction. The vital principle, therefore, must be A MOTIVE POWER, capable of imparting motion to atoms at rest, and of opposing resistance *to other forces* producing motion, such as the chemical force, heat, and electricity. We are able to reliquefy and redissolve albumen, after it had been coagulated by heat, but *the vital principle* ALONE is capable of restoring the original order and manner of the molecular arrangement in the smallest particles of albumen. Coagulated albumen is again converted into its original form, it is transformed into flesh and blood in the animal organism.

"In the formation of vegetable and animal substances, *the vital principle opposes,* as a force of resistance, the action of the other forces,—cohesive attraction, heat, and electricity,—forces which render the aggregation of atoms into combinations of the highest order impossible, except in living organisms.

"Hence it is, that when those complex combinations which constitute organic substances are withdrawn from the influence of the vital force,—when this no longer is opposed to the action of the other disturbing forces, great alterations immediately ensue in their properties, and in the arrangement of their constituents. The slightest chemical action, the mere contact of atmospheric air, suffices to cause a transposition of their atoms, and to produce new arrangements; in one word, to excite *decomposition.* Those remarkable phenomena take place which are designated by the terms FERMENTATION, PUTREFACTION, and DECAY; these are the processes of decomposition, and their ultimate results are to reconvert the elements of organic bodies into that state in which they exist before they participate in the processes of life."

The reader, however, will be more astonished to learn that he has not discovered, amid the multitude of conflicting statements and doctrines, a passage in the work on *Animal Chemistry* which, even more than the preceding, identifies "the *Reformer*" with the most exclusive vitalists, and completely annuls all his chemical and physical speculations as to organic life, and his radical distinctions between plants and animals (§ 350, nos. 7, 12, 15). It will be also seen with what pretense he has been denominated "*the Reformer*," and "*the author of a new and the greatest era in physiology*." The extract inculcates the doctrines of an independent vital principle, its identity in plants and animals, the action of stimuli upon that principle, its susceptibility of influences from the nervous power in animals, the absence of that influence in plants, and the dependence of all organic processes and results, equally in plants and animals, upon that principle.

Now these are exactly the doctrines which are also fundamental throughout the Medical and Physiological Commentaries and these Institutes. They are relative to the constitution and processes of organic beings as a whole, while the foregoing quotations from Liebig's Lectures comprehend the principles by which I have interpreted the elementary condition of organic bodies. Thus our author:

"*The activity of vegetative life manifests itself, in* VEGETABLES, *with the aid of external influences;* IN ANIMALS, *by means of influences produced within the organism. Digestion, circulation, secretion, are, no doubt, under the influence of the nervous system; but* THE FORCE *which gives to the germ, the leaf, and the radical fibres of the vegetable* THE SAME WONDERFUL PROPERTIES, *is the* SAME *as that residing in the secreting membranes and glands of animals*, and which enables every animal organ to perform its own proper functions."—LIEBIG'S *Animal Chemistry.*

60. "The diversity of the transformations and of the resulting products," says an able advocate of Liebig's physical doctrines of life, "indicate most certainly the complexity of an organic product" (§ 41). "The metamorphoses which occur after organic substances are removed *from the influence of the vital force*, constitute a separation, or splitting up into new and less complex compounds" (§ 54).—MR. ANCELL, *in London Lancet, Nov.* 26, 1842.

Thus, again and again, does the chemical physiologist unavoidably concede that the elements of organic beings are held together by a vital principle, and, therefore, that they are originally united by that principle.

Vitalism becomes established in all its aspects, even in what has been denominated "transcendental vitalism," when it may be shown that the elements of organic beings are, in the language of Liebig, "*united by a peculiar mode of attraction, resulting from the existence of a power distinct from all other powers of nature, namely, a Vital Principle;*" since, as I have said, the powers and laws which regulate the composition must be at the foundation of all the subsequent results. Concessions of fundamental principles overthrow all spurious "facts," and all secondary doctrines of a conflicting nature. These, therefore, may be advantageously connected with demonstrations of the truth. There are few intelligent minds that do not rightly appreciate those grand phenomena of Nature which conduct us to

a knowledge of her fundamental laws, or do not incidentally betray their conviction of the right, however the enticements of fame may beguile them into ingenious substitutions. I shall, therefore, as on all former occasions, continue to bring to the aid of my conclusions the powerful concessions of the most eminent men who belong to the adverse schools in organic philosophy. It is manifest that such authorities must weigh with the force of demonstration, since it is obvious that their admissions can only flow from convictions that have been obtained in the school of Nature. Among the most illustrious of the adverse school is Liebig, and standing intermediate is the profound and erudite Müller. And having thus referred again to this great philosopher, I will not lose the opportunity of obtaining from him an important contribution to the doctrines of vitalism as they relate to the very composition of organic beings, and in which he institutes a broad contrast between the affinities which unite the elements of organic and inorganic compounds. Thus:

"Chemical substances," says Müller, "are regulated by the *intrinsic* properties and the elective affinity of the substances uniting to form them. In organic bodies, on the contrary, the power which induces, and maintains, the combination of their elements, does not consist in the *intrinsic properties* of those elements, but in *something else,* which not only *counteracts* those affinities, but effects combinations in *direct opposition* to them, and *conformably* to the laws of its own operation."—MÜLLER, *Elements of Physiology*, p. 4.

Liebig, also, variously inculcates the same great principle. Take, in the first place, a demonstration the converse of Müller's. It is the last paragraph in the work on Organic Chemistry. Thus:

"The same *numerous causes* which are opposed to the formation of complex *organic molecules,* under ordinary circumstances, *occasion their decomposition and transformations* when the only ANTAGONIST POWER, THE VITAL PRINCIPLE, NO LONGER COUNTERACTS THE INFLUENCE OF THESE CAUSES. New compounds are formed in which CHEMICAL AFFINITY HAS THE ASCENDENCY, and opposes any farther change, while the conditions under which these compounds were formed remain unaltered."

Again, we are informed by this chemist, that

"The equilibrium in the chemical attractions of the constituents of food is disturbed by the VITAL PRINCIPLE, as we know it may be by many other causes. But the union of the elements, so as to produce NEW COMBINATIONS *and forms,* indicates the presence of A PECULIAR MODE OF ATTRACTION AND THE EXISTENCE OF A POWER DISTINCT FROM ALL OTHER POWERS OF NATURE, namely, the VITAL PRINCIPLE." "If the food possessed life, not merely the chemical forces, but THIS VITALITY would offer resistance to the VITAL FORCE of the organism it nourished." "The individual organs, such as the *stomach,* cause all the organic substances conveyed to them, which are capable of transformation, to assume new forms. The stomach *compels* the *elements* of these substances to unite into a compound fluid for the formation of blood."—LIEBIG'S *Organic Chemistry*, p. 356, 357, 346, 384.

61. It is a remarkable characteristic of organic beings that they are composed chiefly of combustible substances, properly so called, and a supporter of combustion; with the principal exception of that anomaly in the inorganic kingdom, nitrogen gas (§ 37).

62, *a.* The general introduction of nitrogen gas into the constitution of animal compounds, and into many of a vegetable nature, while it is excluded from mineral compounds, is one of the most striking distinctions between the two kingdoms of Nature. Upon that distinction I have founded an argument, in my Essay on the "Philosophy of Vitality," in proof of the difference in the powers and laws by which the two kingdoms are governed. It appears also appropriate to this work that the proof should be here introduced.

62, *b.* I have said in the foregoing Essay, that it is abundantly evident that living beings are endowed with properties which protect their elementary composition against all those decomposing agencies which are perpetually separating the elements of all mineral compounds. This shows that the properties, by which the elements of living beings are united, are utterly different from such as combine the elements of inorganic compounds. Nevertheless, the living organization is undergoing a systematic change, a perpetual decomposition, surpassing any mutations that are in progress in the surrounding world. These decompositions are, also, of a peculiar nature, governed by established laws, various in different parts of the same individual, yet forever the same in any given part (§ 44). I shall not stop to show how the old are replaced by new materials, and how the processes go on *pari passu*, and in opposition to all the philosophy which chemistry teaches, but only say that the decompositions must be effected by properties as peculiar to the living compound as are the results; and that these results conspire with the peculiar modes in which the elements are combined in proving the existence of specific properties, which are the common cause of all the harmonious phenomena of living beings (§ 38–42).

62, *c.* When, however, the organic being dies, a new order of decomposition begins, eminently of a chemical nature, and in forcible contrast with that which concerns the vital process of renewal. This is due to the special element, nitrogen gas, which may be called the *principle of dissolution.* Wherever present, it gives rise to transformations and disunion of all the other elements after the properties of life have lost their sway. The moment these cease, chemical decomposition begins,—confusedly, violently; and such are the nature and combinations of the elements, that their disruption would go on with no other contribution from surrounding agents than water alone. Hence the more rapid transformations and dissolution of animal than of vegetable tissues, and of sap and other substances which are generated by vegetable organization.

62, *d.* Liebig says of nitrogen gas, that "there is some peculiarity in its nature, which gives its compounds the power to decompose spontaneously with so much facility. Now, nitrogen is known to be the most indifferent of all the elements. It evinces no particular attraction to any one of the simple bodies, and this character it preserves in all its combinations; a character which explains the cause of its easy separation from the matter with which it is united." And again, "When those substances are examined which are *most prone* to fermentation and putrefaction, it is found that they are all, *without exception*, bodies which contain nitrogen."—LIEBIG'S *Organic Chemistry applied*, &c., p. 241.

62, *e.* In the inorganic kingdom, nitrogen is mostly confined to the

atmosphere, where it probably exists in a state of simple intermixture with oxygen. "All bodies which have an affinity for oxygen abstract it from the atmosphere with as much facility as if the nitrogen were absent altogether;" and we have striking examples of the disposition of nitrogen to separate from its compounds, "in the easy transposition of atoms in the fulminating silvers, in fulminating mercury, and in all fulminating substances," whose ready explosion is owing to the presence of nitrogen. "All other substances," says Liebig, "containing nitrogen acquire the same power of decomposition when the elements of water are brought into play."

62, *f*. Now the foregoing characters belong to nitrogen only as it exists in inorganic or in dead organic compounds, while the former, also, are artificial, or due to accidental causes. In living beings, where it abounds,* it adheres to its associated elements with a tenacity which no agent can impair till it destroys the life of the part; or, in other words, till it destroys those vital properties by which the elements were truly united. It is then, however, that the forces of chemistry take possession, and the elements may explode, I had almost said, with the facility of the fulminating compounds.

62, *g*. "There is," says Liebig, "in the nature and constitution of the (inanimate) compounds of nitrogen, a kind of tension of their component parts, and a strong disposition to yield to transformations, which effect spontaneously the transposition of their atoms *on the instant* that water or its elements are brought in contact with them." On the contrary, "it is found that no body destitute of nitrogen possesses, when pure, the property of decomposing spontaneously while in contact with water."—LIEBIG.

But, although dead animal compounds readily pass into spontaneous decomposition under slight degrees of moisture, yet, composed as they are, in part, of the elements of water, and very largely impregnated with aqueous substances in their living state, neither those elements, this water, nor any other agent, can disturb the exact combinations.

But, when the organic being dies, chemical agencies have their play, and it is then that

"The result of the known transformations of substances containing nitrogen proves," according to Liebig, "that the water does not merely act as a medium in which motion is permitted to the elements in the act of transposition, but that its influence depends on chemical affinity. When the decomposition of such substances is effected with the assistance of water, the nitrogen is invariably liberated in the form of ammonia."—LIEBIG.

In respect to the inorganic world, had nitrogen been incorporated in its compounds, there would have been no stability among them. They would have been perpetually undergoing decomposition, until finally the whole of the nitrogen would fly off by itself, and nothing of the original compound would remain; and it could never be recombined.

62, *h*. Besides the disposition of nitrogen to tear asunder the ele-

* Nitrogen is well known to abound in all the tissues of animals. Of vegetables, Liebig says, that, "Estimated by its proportional *weight*, nitrogen forms only a very small part of plants, but it is never entirely absent from *any part* of them. Even when it does not enter into the composition of a particular part or organ, it is always to be found in the fluids which pervade it."—LIEBIG'S *Organic Chemistry applied to Physiology*, &c., p. 4.

ments with which it may be combined, the complexity of these elements in organic beings contributes to the disorganizing results after death, and is another principal cause of spontaneous fermentation and putrefaction (§ 38, 41, 46, 48, 52, 53).

62, *i.* From the foregoing facts, especially from the universality and fixedness of nitrogen in organic beings, I arrive at the conclusion that the elements of their compounds are united by forces as peculiar as the facts which relate to these compounds, and that the forces of chemistry have no agency in combining the elements, or in effecting changes of their combinations during life. It is also abundantly manifest from my premises, that Liebig's declaration that "by chemical agency we can produce the constituents of muscular fibre, skin, and hair," is without the slightest foundation (§ 12, 13, 14).

62, *k.* The whole labyrinth of combinations in organic beings, and their ultimate return to binary compounds, are full of the most stupendous design. The final cause of the reduction of the organic being, when its own specific purposes are ended, is that of again supplying the means of growth to vegetables yet alive, that the elements may be again elaborated into ternary and quaternary compounds, to carry out the final purpose of the vegetable kingdom in supplying nutriment to animals (§ 303).

63. In the Essay to which I have referred in the last section, I have endeavored to deduce the principles of vitalism from the phenomena that attend the development of the incubated egg, as had been briefly set forth in my "Examination of Reviews." The considerations there made are peculiarly appropriate to the present work, and to the place at which I have now arrived. It was my object to consider,

1st. The constitutional nature of the ovum.

2d. To show by the philosophy of generation, and by the nature of the powers which are universally admitted to be alone concerned in developing the germ or ovum, and in forming the organs of the new being, that the *same* powers are, also, *alone* concerned in carrying on forever afterward the processes of life, and, of course, that no new powers, or principles, are introduced.

3d. To consider the manner in which the germ is impregnated, or its vital properties so stimulated into action as to result in the development of the germ, and in unfolding the various attributes of the new being.

4th. To show that we may find in the physiology of generation, or the principles through which the ovum is impregnated, the whole philosophy of organic life, or the principles through which the actions of life are forever carried on.

5th. To state the manner in which the natural peculiarities of each parent, whether as it respects the properties of life, or the physical conformation, are infused into the germ and combined in the full-grown offspring.

6th. To show that hereditary diseases are transmitted in the same way as those more natural peculiarities which belong to parents.

7th. To show, also, that the principles which are concerned in the transmission of hereditary diseases are the same as concur in the production of ordinary diseases.

8th. To deduce from the philosophy of generation the vital nature of hereditary diseases; or, in other words, to show that the morbid

impression is established upon the vital properties of the ovum, and, of course, upon those of the new being; and that the hereditary vitiation does not consist in any transmitted impurity to the blood or other fluids of the offspring, as is now supposed by the humoralists.

If the foregoing propositions be true in relation to man, they will, of course, be equally so of animals, and of the whole vegetable kingdom (§ 169, *f*).

64, *a*. If it be universally conceded, as a matter of course, that not only the elementary constitution of the ovum, but its whole development, depends entirely upon a vital principle or vital properties, it will follow that the same principle or properties are forever afterward concerned in organic processes, and *alone* concerned.

Let us hear, in the first place, the most eminent in the school of vitalism, but who are inclined to lean upon chemistry after the full development of the ovum.

64, *b*. It is said, for example, by Tiedemann,

"That it is the *vital power*, which in the fecundated germinative liquid, brings the molecules of the organic combinations to the solid form, and calls the first lineaments of the vegetable and animal embryo into existence. All the parts and tissues that are formed in it, according to a definite order of succession, are products of the power of formation, and on this they depend in all that relates to their first appearance, their development, aggregation, configuration, and arrangement. The phenomena exhibited in the act of formation of an embryo, are placed *far above* all the mechanical and chemical acts we observe in bodies not endowed with life."—TIEDEMANN, *Comparative Physiology*.

64, *c*. By the illustrious Müller, it is said,

"The *creative* force exists already in the germ, and *creates* in it the *essential parts* of the future animal. The germ is *potentially* the *whole* animal. During the development of the germ, the *essential parts* which constitute the *actual* whole are produced." "The entire *vital principle* of the egg resides in the germinal disk alone; and since the external influences which act on the germs of the most different organic beings are the same, we must regard the simple germinal disk as the *potential whole* of the future animal, endowed with the *essential* and *specific force* or principle of the *future* being, and capable of increasing the very small amount of this *specific force* and *matter* which it already possesses, by the assimilation of new matter." And again he says, "This *force* exists *before* the harmonizing parts, which are, in fact, FORMED BY IT during the development of the embryo." "The *vital force* inherent in organic beings *itself generates* the essential organs which constitute the whole being." "The formative or organizing principle is a CREATIVE POWER, modifying matter blindly and unconsciously;" yet with such wonderful precision that Müller also says, that "this RATIONAL CREATIVE FORCE is exerted in every animal strictly in accordance with what the nature of each requires." "The vital principle," he says, "is in a quiescent state in the egg before incubation."—MÜLLER, *Elements of Physiology*.

64, *d*. Passing from the chemico-physiological school to that of pure chemistry, we shall find the same admissions as to the exclusive agency of a vital principle in the formation and development of the

seed and ovum. The extraordinary contradictions, which will astonish the reader, necessarily abound in all authors who are employed in identifying two subjects that have no relation to each other.

64, *e.* Take Liebig, as a first example; and take, in the first place, his chemical doctrine of life.

"In the animal body," he says, "we recognize, as the ultimate cause of all force, only one cause, *the chemical action* which the elements of the food and the oxygen of the air mutually exercise on each other. The only known ultimate cause of vital force, either in animals or in plants, is a CHEMICAL PROCESS. If this be prevented, the phenomena of life do not manifest themselves. If the chemical action be impeded, the vital phenomena must take new forms."

And yet only a few sections before, and in the very first sentence of Liebig's work on "Animal Chemistry applied to Physiology and Pathology," we read,

"In the animal ovum, as well as in the seed of a plant, we recognize A CERTAIN REMARKABLE FORCE, the SOURCE of growth or increase in the mass, and of reproduction, or of supply of the matter consumed; *a force in a state of rest.** By the action of external influences, by impregnation, by the presence of air and moisture, the condition of static equilibrium of this force is disturbed. Entering into a state of motion or activity, it exhibits *itself in the production of a series* of forms, &c. This force is called the *vital force*, *vis vitæ*, or *vitality*." —LIEBIG'S *Animal Chemistry*.

Turning back to the same author's work on "Organic Chemistry applied to Physiology," we not only meet with a similar contradiction of his grand doctrine of the entire dependence of life upon chemical processes (and as we had before seen in respect to digestion, section 60), but with that which is particularly apposite to my present inquiry.

"Our notion of life," says Liebig, "involves something more than mere reproduction, namely, the idea of an ACTIVE POWER *exercised by virtue of a definite form*, and production and generation in a definite form (§ 59). The production of organs, the co-operation of a system of organs, and their power not only to produce their component parts from the food presented to them, but to *generate themselves* in their original form and with their properties, are characters belonging *exclusively to organic life*, and constitute a form of reproduction INDEPENDENT OF CHEMICAL POWERS. The *chemical forces* ARE SUBJECT to the INVISIBLE CAUSE BY WHICH THIS FORM IS PRODUCED. This VITAL PRINCIPLE is only known to us through the peculiar form of its instruments; that is, through the organs in which it resides. Its LAWS must be investigated just as we investigate THOSE OF THE OTHER POWERS WHICH EFFECT MOTION AND CHANGES IN MATTER."—LIEBIG'S *Organic Chemistry*, &c., p. 355.

64, *f.* Roget, of high authority, maintains that,

"However the laws which regulate the vital phenomena may appear, on a superficial view, to differ from those by which the physical changes taking place in inorganic matter are governed, still there is really no essential difference between them." "It may, in like manner, be contended, that the affinities which hold together the elements of living bodies, and which govern the elaboration of organic products, ARE THE SAME with those which preside over inorganized compounds."

* See my *Examination of Reviews*, p. 7–28.

"Hence it becomes every day more and more probable that the forces immediately concerned in the production of chemical changes in the body, ARE THE SAME as those which are in constant operation in the inorganic world; and that we are not warranted in the assertion that the operations of vital chemistry are directed by distinct laws, and are the results of new agencies."

"However *natural it may be* to conceive the existence of a single and presiding principle of *vitality*, we should recollect that this, in the present state of our knowledge, is only A FICTION OF THE MIND, NOT WARRANTED BY THE PHENOMENA THEMSELVES."—ROGET'S *Outlines of Physiology.*

Let us now hear this able writer on the suject of fœtal development.

"A portion of the VITAL POWER of the parent," he says, "is for this purpose employed to give origin and birth to the offspring. The utmost solicitude has been shown in every part of living nature to secure the perpetuity of the race, by the establishment of LAWS, of which the operation *is certain in all contingent circumstances.*"

Roget ultimately describes, in his usual felicitous manner, the development of the ovum; and here we have nothing from our author but the agency of the *vital powers.*

"The foundations of the edifice," he says, "are laid in the homogeneous jelly *by the* EFFORTS OF THE VITAL POWERS." "At first, all the ENERGIES OF VITALITY are directed to the raising of the fabric, and to the extension of those organs, which are of greatest immediate utility; but still having a prospective view to farther and more important ends,"—and so on throughout the chapter; the whole work of developing and fashioning the fœtal organs being assigned, exclusively, to "the efforts of the vital powers," and to the "energies of vitality."—ROGET'S *Animal and Vegetable Physiology, Bridgewater Treatise.*

64, *g. Finally*, let us hear, also, Dr. Carpenter, who advocates the chemical doctrines of life so far as to lay down the following principle no less than twice within six pages, and in nearly the same words. Thus:

"Reason," he says, "has been already given for the belief that the affinities which hold together the elementary particles of *organized* structures are not different from those concerned in the *inorganic* world; and it has been shown that the tendency to DECOMPOSITION AFTER DEATH BEARS A VERY CLOSE relation with THE ACTIVITY OF THE CHANGES WHICH TAKE PLACE IN THE PART DURING LIFE."—CARPENTER'S *Principles of General and Comparative Physiology*, p. 140; also, p. 146.

Now the authority of such a writer, and a prominent leader in the purely chemical school of physiology, must be allowed to be important when any unavoidable concession is made to vitalism. Let us then hear him in the matter of the ovum:

"Organization, and *vital properties*," he says, "are simultaneously communicated to the germ by the structures of its parent. THOSE VITAL PROPERTIES CONFER upon it THE MEANS of itself assimilating, and THEREBY ORGANIZING AND ENDOWING WITH VITALITY *the materials supplied by the inorganic world.*"—CARPENTER'S *Principles*, &c., p. 138.

And again, this mere chemist, in his general views of the philosophy of life, observes, that

"The AGENCY of VITALITY, as Dr. Prout justly remarks, does not change the properties of the elements, but simply COMBINES THEM [the elements] IN MODES WHICH WE CANNOT IMITATE."—CARPENTER'S *Principles*, &c., p. 146.

64, *h*. Dr. Prichard is strictly of Dr. Carpenter's school (see my "Examination," &c., p. 37), between whom there is a point of agreement which is worth noticing in its connection with the subject now before us, and to which I have referred in a former work, in its relation to Dr. Carpenter. Both of these writers see so much of peculiar design in organic nature, and find it so impossible to interpret the phenomena of organic beings upon the chemical and physical principles which they have so strenuously set forth, and in their aversion to any other principles, and to the obvious rule of analogy as to second causes, that, in the end, they assign the functions and phenomena of life to the *immediate* action of the Deity.

"The theory of a vital principle," says Dr. Prichard, "has been applied in a different manner, to account for the phenomena displayed at the beginning of life in animals and vegetables, and to get rid of the mystery which attends the gradual evolution of organic structure from ova and germs. Here the vital principle *is no longer considered a chemical agent*, but assumes the character of a plastic and formative power," &c.

Now Dr. Prichard "cuts the knot" and "gets rid of the mystery' after the following manner:

"We may," he says, "if we choose to do so, term the cause which governs the organization and *vital* existence a plastic principle; but it is a principle ENDOWED WITH INTELLIGENCE AND DESIGN [!] It is, in fact, nothing more than the Energy of the Deity." "The development of forms, according to their generic, specific, and individual diversities, not less in the vegetable than in the animal world, can only be accounted for by ascribing it to the universal energy and wisdom of the Creator."—PRICHARD'S *Review of the Doctrine of a Vital Principle*. See, also, PAINE'S *Commentaries*, vol. i., p. 10, 25; and his *Examination of Reviews*, p. 37, 41, 43, 44.

This is a far greater admission than the vitalist can desire; since, if the development and growth of the germ depend immediately upon Almighty Power, so must all the analogous processes of the living being at all stages of its existence, and science would be merged in the direct manifestations of that Power. But, while this doctrine is utterly exclusive of all the assumed chemical agencies at all periods of life, and overlooks the analogy between the development of the germ and the subsequent processes, there can be no hesitation as to the disposition which should be made of it, without any reference to its prevaricating nature (§ 179 *d*, 699 *c*, 740).

65. Having now before us a plain statement of our necessary premises as they respect the exclusive agency of the "vital principle," or "organic force," or "creative power," or "vital properties," or "vital powers," or "vitality" (whichever term may be preferred), in carrying out the full development of the embryo, it may be interesting to know the details of that development and growth, which is thus allowed, on all hands, to be conducted by powers utterly distinct from the chemical and physical, and in which these have no agency.

"The development of the separate parts," says Müller, "out of

the simple mass, is observable in the incubated egg. All the parts of the egg, except the germinal membrane, are destined for the nutrition of the germ. The simple germinal disk is the potential whole of the future animal, endowed with the essential and specific force, or principle of the future being, and this germ expands to form the germinal membrane, which grows so as to surround the yolk; and by *transformation* of this germ, the organs of the future animal are produced. The rudiments merely of the nervous and vascular systems, and of the intestinal canal, are first formed; and from these rudiments the *details* of the organization are afterward more fully developed; so that the *first* trace of the central parts of the nervous system must be regarded neither as brain nor as spinal marrow, but as still the *potential* whole of the central parts of the nervous system. In the same manner, the different parts of the heart are seen to be developed from a uniform tube; and the first trace of the intestinal tube is *more* than the mere intestinal tube; it is the *potential* whole, —the representative of the entire digestive apparatus; for, as Baer first discovered, liver, salivary glands, and pancreas, are, in the farther progress of the vegetative process, really developed from that which appears to be merely the rudiment of the intestinal canal. It can be no longer doubted that the germ is *not* the miniature of the future being, with all its organs, as Bonnet and Haller believed, but is merely *potentially* this being, with the SPECIFIC VITAL FORCE of which it is endowed, and which it *becomes actually* by development, and by the production of the organs essential to the active state of the *actual* being. A high magnifying power is not necessary to distinguish the first rudiments of the separate organs, which, from their first appearance, are distinct and very large, but simple. So that the later complicated state of a particular organ can be seen to arise by transformation from its simple rudiment. These remarks are now no longer mere opinions, but facts; and nothing is more distinct than the development of glands from the intestinal tube, and of the intestinal tube itself from a portion of the germinal membrane." —MÜLLER, *ibid.*

Such, then, is the history of the development of the germ in birds, and in all the higher animals; and the whole work is ascribed by physiologists of every denomination exclusively to principles unknown in the inorganic world, and wholly distinct from any of a chemical nature. They are called, indiscriminately, *vital properties*, *vital powers*, *vital principle*, *organic force*, *creative force*, &c., to distinguish the principle, or properties, from every thing that has any known existence in inorganic substances, or as the source of any in organic results. But, physiologists of the chemical school stop here, and ascribe all organic compounds after the being is fully formed to chemical agencies. It is remarkable, however, that it has not occurred to these philosophers, that precisely the same elementary combinations, the same formation into tissues, and the same secretions, take place at all stages of the rudimentary development as at all future periods of life, and that the rudimentary development consists in these formations of simple compounds and their union into tissues; and if the early or rudimentary growth of the being, all its secreted products, all its elementary combinations, be determined by the vital properties, so are the *same* results determined by the same properties

or powers forever afterward. To call in the agency of chemical or physical forces, to accomplish *precisely* the same results at any future stage of the organic being as are admitted to be performed in the development of the "essential parts" of that being by the "vital principle" or "vital properties" alone, is not only a violation of the plainest rule in philosophy, but of the clearest facts (§ 41, 42, 55–58).

66. We have thus before us a peculiar order of powers by which the organic being is developed, fashioned, and forever exclusively governed. It is these powers about which physiology, pathology, and therapeutics, are essentially concerned. We may, therefore, seek in the composition of organic beings, and in the laws of their development, *for the whole rudimentary principles of medicine.* The vital principle has also the extraordinary task of laying out, in the ovum, the whole organization of the future being; so that its subsequent labor must be comparatively simple, and it is then, least of all, that it can require any help from the forces of the inorganic kingdom, or that it would permit a violation of the great principle in nature, of avoiding an unnecessary multiplication of causes.

67. It may be farther shown, by the incipient development of the ovum, that the vital powers, or properties, are more concerned in the growth, nutrition, and all the subsequent physical results, throughout the whole existence of the being, than is generally supposed by even the exclusive vitalists. The usual supposition is that the vessels or instruments of action, which are moved by the vital powers, perform the work of decomposing the blood and other parts, and recombining them again in other proportions and forms, according to the particular organization of parts, and the modification of their vital states. It has been the doctrine of all physiologists of the present day, that the ovum, in its germinating part, is a mere organic fluid, destitute of vessels, and all other parts of the future apparatus. Very lately, however, it has been asserted, on the authority of the microscope, that the rudiment of a cell has been discovered; and what is thought by some to render this probable was the simultaneous discovery of the hypothetical spermatozoa, the ancient *homunculus,* within the ovum after copulation.

Whether, however, such a rudiment has been detected, or whether the doctrine of the "homunculus" is destined for a temporary revival, there can be no doubt that the first "assimilation of new matter" must take place without the agency of vessels, or of any parts which are subsequently formed; and, therefore, the same powers which converted the fluid germ into vessels, nerves, &c., continue to make the same conversion out of blood; and as all this was originally done without the aid of vessels, so must the same powers be forever carried on with their subsidiary agency only. Nothing in mathematics can be more certain, and nothing, therefore, more incontrovertible.

We see, therefore, that Müller, reasoning upon other grounds, may not have been altogether hypothetical in his inference that the "vital principle exerts its influence even beyond the surface of an organ, as shown by its effects on the chyle, in maintaining the fluidity of the blood," &c.

By the same rule, it may be at once shown that the only ingenious chemical hypothesis ever invented to interpret organic results,—the *catalytic,*—is purely an assumption; since this hypothesis is predica-

ted of the blood-vessels. But, if there be no vessels in the germ, the first vessels must, of course, be produced without the supposed chemical influence of vessels, and, by my showing, therefore, as to the subsequent formation of vessels and other parts, the supposed agency of the catalytic forces is a mere assumption (§ 41, 42; also, *Medical and Physiological Commentaries*, vol. i., p. 74–76).

On this subject, too, chemistry must abide by admissions which are made in the very face of consistency; so imperative is fact, and so imbecile is hypothesis. Thus, it is said by the distinguished chemico-physiologist, Dr. Prout, that

"The most determined sceptic cannot assert that there is any necessary relation, or, indeed, ANY RELATION WHATEVER, between the mechanical arrangements and the chemical properties to which they administer. There is NO REASON why the chemical changes of organization should result from the mechanical arrangements by which they are accomplished [!]; neither is there the SLIGHTEST REASON why *the mechanical arrangements*, in the formation of organized beings, *should lead to the chemical changes of which they are the instruments*" *!*—DR. PROUT'S *Bridgewater Treatise.*—Such is the proof which chemistry offers.

68. The question then arises as to what is the particular office of those vessels where the elementary combinations and decompositions take place? Simply this: to convey, and eliminate through the agencies of the vital properties, those parts from the blood out of which the vital properties effect the new elementary combinations, whether solid or fluid,—to aid in arranging the new molecules, and to carry forward those fluid products which may be destined for other ends.

69. But, have not the nerves an indispensable agency in effecting the elementary combinations and decompositions? Certainly not, for the reasons stated in relation to the blood-vessels (§ 67, 68); and this induction concurs with all other facts, and overthrows the hypothesis that the nerves are conductors of galvanism, and, therefore, the supposed agency of this fluid in the processes of life.

70. But, all the vessels, and all the solid parts of the organism, have their various specific offices. Here, in every part, reside the vital properties, which had been fully developed in the ovum, and here are they modified according to the exact nature of the organization and the peculiar final causes of "the properties of the vital principle" in each part. Hence they manifest peculiarities in parts that are nearly analogous. The modifications vary, for instance, in the serous membranes, and more remarkably in the mucous, as known by the influence of foreign agents, their phenomena, their products, &c. The vital properties differ in different parts of one and the same continuous tissue, as in the mucous tissue of the nose, lungs, stomach, &c. Hence one of the important objects of studying the structure of organs, and the nature of their tissues; for, as the vital properties are naturally modified in different parts, so will their alterations in the same disease be different in different tissues of one organ, and, for the same reason, even of different parts of one continuous tissue.

These natural modifications of the vital properties in different parts have, at least, three great final causes. The first is what I have already stated, namely, to separate from the blood, through the agency of the capillary vessels, that exact part which is to be decompounded

at any given point; the second is, by these modifications, to enable "the properties of the vital principle" to decompound and recombine the elements according to the exact nature of the combinations which belong to the part; and the third, to qualify the properties, through the medium of the capillary vessels, to shape and unite the new molecules to the old. It is easy to apply this principle, under its different aspects, to all other vessels, as the veins, the secretory and excretory vessels of the glands, and the absorbents.

71. Now, at the first start of the development of the germ, "the properties of the vital principle" (as they are well designated by Müller) are but very imperfectly, if at all, aided by any of the foregoing physical means, though they come into operation at the moment they are successively produced. "The properties of the vital principle," therefore, must exist in that organic fluid, in a modification, and with a formative energy which they do not possess in any of the new developments; and herein it will have been seen that the very chemist has come to this conclusion (§ 64 *f*, 190 *b*.).

72. The process of generation presents a varied and most impressive illustration of the peculiarities of the vital properties, and of the manner in which they are liable to be impressed and permanently modified in their nature. It results in the production of organic beings similar to those which exercise the generative faculty. This faculty is therefore manifested with as many specific modifications as there are different species of organic beings. If we allow to the globe one million of distinct species of animals, the specific modifications of the germinal product will be as numerous, and these are more or less influenced by the semen of the male. The seminal or productive principle of the male exerts its special influences upon the living properties of the germ, and according to the special constitution of the ovum, directs their operation in such a manner that none but beings of the same kind with the parents, where both are of the same species, are produced. That the various modifications which distinguish each species are determined by both parents, is fully demonstrated in hybrid animals, and is sufficiently obvious in the transmission of the peculiarities of the male or female, where the individuals are of the same species. And, notwithstanding our supposed million of distinct species of animals, and the specific variations in all the parts of each species (§ 41), this almost endless variety is made up by successive depositions of elementary compounds out of mainly four simple substances (§ 37, 42, 46), three of which are gaseous, united in modes unknown to chemistry (38–40, 48), and which chemistry cannot detect, and forever uniting in different modes and proportions according to the exact nature of every part (§ 43, 44). The act of generation establishes the essential modifications which are to be continued, without variation, throughout the life of the new being; and this new individual, becoming in its turn the agent of procreation, perpetuates all the specific modifications which appertain to itself and to its ancestors. The intermingling of species, which results in hybrid animals, proceeds upon the same plan. It must therefore necessarily be, that the vital properties of the ovum are so impressed by the exciting influences of the semen, that those peculiar elementary combinations and aggregations are started which ultimately make up the hybrid. "These vital properties," says Dr. Carpenter, "confer upon it *the means* of itself

assimilating, and thereby *organizing*, and *endowing with vitality*, the materials of the *inorganic* world;" leaving it, also, clear to all minds that the action of the semen must be exerted directly upon the vital properties of the ovum (§ 189).

That this important question as to the direct action of the semen upon the vital properties of the ovum, and its capability of establishing certain modifications of these properties, and that the humoral interpretation of transmitted peculiarities is an unfounded assumption, may be definitively settled, I will also add,

"The well-known fact, that when the Earl of Morton's Arabian mare was covered by the quogga, not only did the mule so begotten partake of the character of the sire, but when the mare was subsequently submitted to an Arabian stallion, by whom she had three foals at different times, the first two continued to exhibit some of the distinctive peculiarities of the quogga conjoined with the characters of the Arabian breed."—MONTGOMERY, *on the Signs and Symptoms of Pregnancy*, p. 17.

The author of the foregoing statement supposes that the semen "may influence several ova, and so continue to manifest its effect in the offspring of subsequent conceptions when impregnation has been effected" by males of another species. The reader will also not fail to remark that the history of this case is in direct conflict with the late attempts to revive the old doctrine of referring the germ to the male parent (§ 67).

73, *a*. The semen, then, is a vital stimulus, and so far on a par with the ordinary stimuli of life. These may be natural, like air, food, heat, &c.; or they may be morbific, like malaria, poisons, &c.; or curative, like medicines. In all the cases, their action is upon the vital properties; and it is in consequence of these influences, that the ovum is developed, that life is maintained, health preserved or impaired, or disease removed. The ova of oviparous animals show the analogy in respect to stimuli, and the principles involved, more impressively than those of viviparous; since by an admirable design, in respect to the former, the impression of the semen has a limited operation, when the vital properties of the ovum return to their quiescent state, but may be again roused into action by the simple stimulus of heat. (See *Med. and Phys. Comm.*, vol. i., p. 21, &c.)

73, *b*. The action of the semen upon the properties of the vital principle of the germ is a type of all the influences that are produced upon the same vital properties during the life of the animal, and from which all its organic actions, and all their results, arise. And so of the germination and growth of plants; which, by-the-way, evinces the common nature of the principle of life, and of organic actions, in the two departments of the animated kingdom (§ 188½, *d*). It is the whole essential philosophy of physiology. It is the alterations produced in the vital properties which constitutes the philosophy of disease, and in which, indeed, all disease virtually consists. It is the art of finding out the remote causes, and the nature of the alterations they produce, and of adapting to the altered condition of the properties of life such agents as shall establish new impressions upon them, and thus enable them to return to their natural state, which forms the basis of therapeutics in its connection with pathology.

74, *a*. Here I shall digress for a moment, to consider certain anal-

ogies in the development of special organs, through the influence of specific stimuli, with that general evolution of the organic fabric which is started by the action of the seminal principle upon the germ. These analogies are to be found in the organs of animal life. The senses, for example, sometimes manifestly require for their full development the prolonged operation of the stimuli which are natural to each. This is habitually observed in the young of some animals, and is seen conspicuously in the subterranean fish of Kentucky. In this last instance organic life is perfectly developed; but, owing to the exclusion of the natural stimulus of the eye from the very outset of life, that organ remains in its rudimentary state.

A fortiori, therefore, the reputedly first inhabitants of this globe, such as the trilobite, attest the existence of the same light at their creation as is enjoyed at the present day; geologists to the contrary notwithstanding.

Superficial observers of nature, either through inattention to the moral consequences, or through infidelity, are apt to believe that physical agents are the real creative forces of organic beings, from observing that particular parts are clearly dependent for their development upon the action of certain specific stimuli. But, in all these cases, the rudiment is there, and has been perpetuated ever since the original species came from the Hand of Creative Power. That Power is entitled to all the praise, as the Author of the rudiment, of its endowment with peculiarly modified properties of life, of the existence of the physical agents, and of the mutual adaptation of these modified properties of the rudiment and the virtues of the physical causes, so that the operation of the latter upon the former shall result, for example, in vision, and, under certain circumstances, as when the ovum is developed and matured out of the body, the physical agent, in the example supposed, shall be necessary to the development of the rudimentary organ of sight (§ 350¾, *h*–350¾, *l*). The principle is much the same as that which applies to the necessity of external heat and light to the development and growth of plants. The specific stimulus of light by which the vital properties and actions of the leaf are enabled to decompound carbonic acid, and to assimilate the carbon, is manifestly a parallel example with the supposed influence of light in developing an animal organ in which the nervous system is extensively incorporated for the final cause of the whole organ; although it be certainly true that, in the case of the eye as of the leaf, the essential influences of light are exerted upon the organic properties of either part, and that the nervous system, in the former case, is only a medium of transmitted influences to the organic properties (§ 188, 188½, 189, 202, 203, 222, 223, 226, 227, 514, *k*).

It would be an interesting inquiry to ascertain whether, by a total exclusion of light from the ovum of fish, after fecundation, the peculiarity of the Kentucky wonder may not be established in the first generation; and whether, also, an exclusion of light for a series of years would not be followed by a failure of the balance of absorption and nutrition in the eyes, and consequently a wasting of those organs. The general law of absorption operates universally, without the aid of any specific stimulus; while it is clearly otherwise in respect to nutrition, and especially in regard to certain organs. The voluntary muscles become emaciated from want of the stimulus of exercise, &c.

We see, therefore, how it happens that fishes with and without eyes may exist together in subterranean caverns as extensive as that of Kentucky; the latter inhabiting the dark regions, while the former exist in springs near the crevices of the cave (§ 136, 137, 548 *a*, 649 *d*, 733 *b*).

74, *b*. Such, then, is the philosophy of this subject, and such the full extent of the ground upon which infidelity would plant its standard. Nor will I dismiss this subject without referring, now and hereafter, to the calm indifference with which this infidelity is regarded even by the religious world, by adducing not a few of the present popular treatises on theoretical geology (§ 350¾; *g–k*).

75. Let us now see if the beginning of individual existence does not supply a key to the whole philosophy of disease, as it does to that of physiology. We have seen that all the actions, and all the results of life, are merely effects which arise from the operation of the vital properties through their organic instruments (§ 65–67, 133, &c., 188, &c.). These properties must be constantly excited into action by foreign agents, as by food, blood, &c., or the properties will become extinct, and, of course, the effects will cease (§ 188½, *b*). Now, the actions in disease are nothing more than the altered actions of health, and the same rule applies to all the morbid products. It follows, therefore, that the properties of life, upon which these altered conditions depend, are modified or altered in a corresponding manner. As a consequence of this, it also results that the vital properties have been varied from their natural state by agents or causes capable of producing the change. These agents make their impressions in the same way as the natural stimuli of life, only the morbific agents at the same time affect the nature of the vital properties, and bring them into a new condition. This new condition constitutes disease.

76. The type of all this may be found in the impregnated ovum. The properties which animate the germ *before* conception are determined entirely by the vital constitution of the female parent. But we have seen that the new being may partake of the physical characters of the male as well as of the female, and it happens not unfrequently that the characteristics of the male are predominant. Hence it follows that the semen so far establishes changes in the original constitution of the vital properties of the germ.

Since, therefore, all the fœtal developments, all their physical peculiarities, depend upon the precise modifications and actions of the vital properties (§ 70), and since these properties in the unimpregnated ovum are determined entirely by the female parent, their nature after impregnation must be more or less affected, and assimilated to the peculiar nature of the male parent in all the cases where the offspring manifest any of the male characteristics. This is entirely analogous, in principle, to the modifications which are produced in the properties of life by morbific causes; but with this difference in contingencies: in the case of the impregnated ovum, the modifications are permanently established, and can never be altered, so far as the vital properties, in either parent, upon which the modifications depend, are fundamental in their nature. In the case of the morbific agent, or the cause of disease, the vital properties are diverted from the healthy state, and from *such* modified conditions they commonly possess the ability of escape, and of returning again to their natural standard (§

853, 858, 898). In the case of the impregnated ovum, a modifying agent operates, whose properties are intended to confer on the new being a stable condition, however they may modify the exact constitution of the impregnated germ. This vital stimulus, the semen, therefore, in virtue of its specific properties, bestows upon the corresponding vital properties of the ovum the peculiarities which belong to itself; and these being natural, vital, and determinate, the transmitted peculiarities should be equally so. Or, where the male parent enjoys a perfectly natural constitution, the innate predispositions to disease depend upon special peculiarities in the vital state of the ovum, which may be as permanently established, through the modified constitution of the female parent, as any of the natural characteristics. In the case of disease, however, the morbific agents have none of the properties of life which are natural to the fecundating semen, and the modifications, therefore, which they may determine may be different, even if we suppose them to act, as in the case of the germ, upon the whole constitution. Whatever modifications, therefore, may arise from their action, they must consist of deviations from the standard of health. But, it does not necessarily follow that certain artificial modifications may not be as permanent as the natural ones; and it is from observation alone, that we learn that they are so, or nearly so; as in the case of artificial "temperaments," the effects of domestication upon animals, the changes which are wrought in the vegetable kingdom by cultivation and by change of climate (§ 535, &c.).

77. In the case, however, of the formation of temperaments by change of climate, and the more remarkable alterations produced in animals by domestication, and in plants by cultivation, &c., the results are brought about by the new and habitual influences to which the properties of life are exposed; and, in all these cases, a radical, and often permanent modification is established, approximating closely the modifications which are bestowed upon the germ by the fecundating semen. Now, it is also true, that what is denominated predisposition to disease is entirely analogous, in principle, to the permanent temperaments of which I have just spoken. Both are results of physical agents, modifying the properties of life; and this chain of analogies conducts us to those predispositions to disease which are impressed upon the germ by the fecundating semen, and by which I show that the philosophy of the operation of morfibic causes is variously, and even exactly exhibited in the impregnation of the germ (§ 63, 75, 535, 539, 559).

78. Take the scrofulous subject as supplying an example of hereditary predisposition to disease. If it exist in the female, her ova will partake of this peculiar modification of the vital properties, and it is in this way that her progeny inherits the scrofulous diathesis (§ 144–147). In this case, as in all transmitted predispositions to disease, the peculiarities induced in the parent have arisen, originally, from the operation of deleterious agents—imbuing the ovum with the modifications belonging to the female, or imparting to the semen the whole concentrated force of what may have been the slow work of numerous causes upon the male parent.

Here, then, we see illustrated in the very ovum, even before impregnation, the whole principle which concerns artificial temperaments, and those influences of morbific agents which establish predis-

positions to disease in the full-grown subject. It frequently happens, also, that this natural diathesis is so great, that it results in actual disease before the birth of the offspring, as manifested by tuberculous affections of the lungs in still-born infants.

79. But, to make the philosophy of this subject more obvious, let us consider the germ when it derives its scrofulous diathesis from the male parent. Before impregnation, its vital condition is perfectly natural. The semen of the male parent establishes upon it the modification which constitutes the predisposition to scrofula, just as malaria determine those modifications which result in fever, &c. And here we may readily detect a perfect analogy between the alterative influences of the semen, and of remedial agents, and come to understand how it is that the latter produce their effects (§ 904, *d*). We have only to observe those instances where some of the offspring inherit the scrofulous diathesis of the female parent, while others are as entirely exempt as the male parent; the natural condition of the semen having altered the vital constitution of the ovum in the latter case, and impressed a disposition to a development of the new being in its perfect state.

80. The subject may be pursued under a variety of aspects, and with various illustrations, whether physiologically or pathologically. Other exemplifications will occur under the subjects of *vital habit* and the *temperaments.* The same principle is concerned throughout, whether in respect to the physiological conditions impressed upon the ovum by the seminal fluid, or as those conditions are modified in hereditary scrofula, gout, &c., or whether it concern the temperaments and other permanent changes that are induced by climate, domestication, &c., or as malaria may establish their peculiar modifications of the properties of life. Nor can such conclusions be unexpected to those who duly consider the simplicity of nature in her elementary principles and laws (§ 561).

81. Could the doctrine entertained by Walker, Elliotson, and others, that the imagination of the parents influences the physical organization of the offspring, be shown, the philosophy which I have set forth, though not rendered more clear, would be yet fortified. But, this is at best but speculation. I could, however, turn to the mysterious production of the soul. This remarkable principle is doubtless developed at the very outset of fœtal life, as evinced by its often combining the intellectual peculiarities of both parents, or, again, of manifesting chiefly those of the male. But here we have no other fact to guide us, and all beyond has been involved in an impenetrable mystery by the great Creator. Here it is a pride and a help of philosophy to rest on faith alone (§ 433).

82. For an examination of vital phenomena, and relative facts, in proof of the existence of properties peculiar to organic beings, and of the abstraction of such beings from the laws of the inorganic world, see Essay on the "Vital Powers," in *Medical and Physiological Commentaries,* vol. i.

SECOND DIVISION OF PHYSIOLOGY

STRUCTURE.

83, *a*. THERE are certain details in respect to the structure of organs which must be stated, now and hereafter, to enable us to comprehend the laws which govern the healthy and morbid states of man.

Perhaps few things can impress us more forcibly with the importance of a correct analysis not only of the physical organization of all parts of the body, but more especially of the vital characteristics of each part, than the continued propagation from high sources of doctrines like the following; while they equally prove my position as to the appropriate sources of knowledge (§ 5¼–5½, &c.), and the tendencies of the microscope.*

83, *b*. The errors in doctrine to which I have referred are revealed sufficiently in the following extract from an article by the distinguished Mr. Paget, contained in the 27th volume of the Transactions of the Royal Medical and Chirurgical Society, London, 1844. The article is entitled "An Account of the Examination of a Cyst containing Seminal Fluid;" in the course of which Mr. Paget observes,

"If, with the aid of these observations, we endeavor to find an explanation of the occurrence of spermatozoa in the fluid of cysts connected with the testicle, we may suppose either that the fluid part of the semen has permeated from the seminal tubes into the cysts, and been farther organized in them; or, that *the cyst itself* secretes a fluid in which the organic structures of the semen may be developed." "The most probable explanation of these cases, therefore, seems to be, that certain cysts, seated near the organ which naturally secretes the materials for semen, may possess a power of secreting a similar fluid."†

I cannot doubt that before I shall have parted with the reader in what I shall have said of the peculiarities of structure, and the more remarkable modifications of vital properties and functions, there will be a disposition to concede the importance of the subject, and that this importance is rendered more manifest by the prevalence of opinions analogous to those in the foregoing extract.

83, *c*. As I have already intimated, however (§ 2, *c*), anatomical science can lead, originally, to no conceptions of the properties and functions of life, and therefore to none of their modifications in disease. The most that we can infer, abstractedly, from a knowledge of structure, are certain general results that are denoted by the constitution of organs, or assemblages of organs, upon the known principles

* See *Medical and Physiological Commentaries*, vol. i., p. 699–712. Also, my *Examination of Reviews*, p. 6, 89, 90.

† The Medico-Chirurgical Review for January, 1845, quotes this paragraph, and observes of it, that "Mr. Paget's explanation of the vicarious appearance of the spermatozoa, which has of late so much puzzled the members of the society, has the merit of being *ingenious* and *original*."—I cannot acquiesce in this decision. The doctrine is old, though recently, for the first time, enforced by the deceptive report of the microscope. It is thus noticed in the *Medical and Physiological Commentaries*: "True, we know that the ancient belief is even maintained at this day, by Sir A. Cooper, and others, that the testis is of no special use, but that the semen is the product of those simple reservoirs, the vesiculæ seminales. But, what does this show?" &c. See, also, my comments on this subject, in vol. i., p. 588, and on the supposed vicarious secretion of milk, urine, &c., p. 601–603.

of Design. The construction of the eye, for example, evinces some great final cause relative to light; that of the urinary apparatus, that a fluid is produced by the kidneys, and conveyed to a receptacle where it accumulates, and is finally evacuated through the urethra; and so of many other parts. We thus infer, also, the uses of each part, individually, from their relations to each other as a system of Design. In other cases the function of a part may be inferred from the known uses of other parts to which it is related; as the valves of the veins, for example, were supposed by Harvey to be designed for giving the blood a direction toward the right cavities of the heart; and this induction from anatomical Design conducted him to a full exposition of the circulation. But, in respect to the great processes of life, no conclusions can be originally drawn but through their phenomena.

Having, however, acquired a knowledge of structure in a particular species of animal, as man, for example, and learned the uses of each particular part by a study of its phenomena, so perfect is the system of Design throughout organic nature, and so harmonious are the analogies of function among organs that bear certain resemblances of structure, or of relations to each other, in all species of animals, although the differences in respect to structure, particularly, may be very great (§ 107, 409, *l*), yet illustrated by greater analogies of relation, we may generally infer, by this analogical process (§ 5¼), the absolute uses of every part in any species of animal that may be, for the first time, subjected to the knife of the anatomist. And this process of induction may be carried to a great extent from an established standard of comparison in the animal to the vegetable kingdom. But the principle is equally comprehensive in respect to plants, when, as with animals, a complex being is marked out, as a standard, in all its structures and functions.

The same is also true, though in a far more limited extent, of the modifications of structure, and the corresponding modifications of function, at the different eras of life (§ 153–162). And when we come to the variations of function in morbid states, though unattended by any appreciable alteration of structure, and consider how various must be the treatment according to the nature of the affected tissue, we are deeply impressed with the indispensable importance, to the physician, of an accurate knowledge of all that is relative to the sensible organization of the material part of organic life (§ 2, *c*). Though the structure, itself, reflect no light upon pathology, excepting through its morbid alterations, an observation of its morbid phenomena leads us to a knowledge of the parts diseased, and this knowledge is important to a just interpretation of the phenomena, and to a right method of treatment (§ 131).

83½. We have now seen that the composition of organic beings is formed by properties peculiar to organic structure, and that what is thus at the foundation presides over all, and is the cause of all that is superinduced upon that composition. The structure of organic beings, which is comprehended under our second division of physiology, is therefore dependent on the same creative cause.

84. The greatest physical characteristic of organized structure is supposed to be its arrangement into cells. Here all analogy with inorganic substances disappears entirely. The chemico-physiologists

imagine that the contradistinction between organic and inorganic beings commences at this step in the ascending series of organic results (§ 42). But we have seen sufficiently that all that relates to the *composition* of plants and animals is equally significant of a radical distinction between the simplest organic compound and those of an inorganic nature; the same powers being equally concerned in the formation of organic compounds as in their arrangement into tissues.

85. The general structure of organic beings is made up of tissues A knowledge of the vital characteristics of the different compound tissues, of the same tissue in separate parts, of the different parts of one and the same continuous tissue as it may pass through different compound organs, of the whole as they may be combined into complex organs, of their vital relations to each other, and of all parts to each other, is indispensable to a knowledge of the laws in physiology, pathology, and therapeutics.

86. Bichat analyzed the tissues more ably than others, and arranged them as follows:

1. Cellular.	
2. Nervous	cerebro-spinal. ganglionic.
3. Muscular	involuntary. voluntary.
4. Vascular	arterial. venous. lymphatic.
5. Osseous.	
6. Fibrous	fibrous. fibro-cartilaginous. dermoid.
7. Erectile.	
8. Mucous.	
9. Serous.	
10. Synovial.	
11. Glandular.	
12. Epidermous, or corneous.	

87. Until the era of Bichat, the tissues were limited to three, as designated by Haller; namely, the cellular, muscular, and nervous. The cellular was supposed to form a large proportion of other tissues.

88. There was a great error, physiological and pathological, in the foregoing limitation (§ 87), since it took no note of the modifications of the vital properties, and of the particular functions of the tissues as arranged by Bichat.

89. The several tissues are distinguished by differences of internal structure, as well as by modifications of their properties and functions. They are called *simple* organs, when considered in their functional character; and when two or more go to the formation of more complex parts, they are called *compound* organs. Certain compound organs, which concur together in some general function, are called an *apparatus;* as the urinary, the digestive, the circulatory, &c. As the whole exist in the universal body, they are called an *organism.* Each tissue, collectively, is also a *system;* as the mucous, serous, muscular, &c.

91. The simple tissues rarely occur in a separate state, but are more or less connected together into complex organs.

92. The simple textures are, themselves, compound organs, so far as their organization is made up of various textures. The union of tissues, therefore, in the simple textures, is quite different and far more intricate than when the simple textures form what is called, specifically, a compound organ.

93. The structure of the general body, and of its different parts, is radiated. The rays, or branches, of certain parts, as the vessels and nerves, are called ramifications. The rays increase in number and diminish in size, as they go off from the centres of radiation.

94. The trunks of vessels and nerves, and their ramifications, unite, respectively, in various ways with each other. This is *anastomosis*, and subserves very important uses. It promotes circulation in the vessels, and through the nerves it contributes especially to bind all the organs together in one harmonious action and common dependence. Through the last, also, the play of remote sympathies is promoted when the nervous power is developed in the central parts of the cerebro-spinal and ganglionic systems by morbific or remedial agents.

95. The animal organism is symmetrical as a whole, and in its various parts. This symmetry is conducive to uniform results, is important to the great processes of life, is always the same in the natural conformation, is indicative of great Design, and of peculiar properties and laws.

96. Bichat, "following the path marked out by nature herself," divided the animal organism into two great systems or classes; the distinction having been already indicated by Aristotle.

97. The first class relates to the individual being; the second to the species.

98. The first class is divided by Bichat into the organs and functions of *animal life*, and the organs and functions of *organic life*.

99. "The two classes have nothing in common, but the general connection that unites all the phenomena of living bodies; but a variety of distinctive attributes characterize them, which cannot be separated from them."—BICHAT.

100. The organs of animal life are those whose functions connect us sensibly with external objects, are peculiar to animals, and distinguish them from vegetables.

101. The organs of organic life consist of such as perform functions that are common to animals and plants. "The only condition of enjoying this life is organization." It forms an indisputable boundary between organic and inorganic bodies.

102. Animals have two states of existence, sleeping and waking; but the former applies only to the division which embraces the functions of animal life. The animal powers are subject to fatigue, and require repose; the organic are not, and are in perpetual operation.

103. The fœtus has only the organic functions in operation; but all its animal faculties and the soul exist in a passive state.* The latter are brought only gradually into exercise.

104. The great, immediate, office of the organs of organic life is to maintain a constant vital composition and vital decomposition of organic matter; or nutrition and waste.

* See *Medical and Physiological Commentaries*, vol. i., p. 13.

105. The organs of digestion, absorption, circulation, respiration, and secretion, compose organic life. Secretion comprehends nutrition, exhalation, calorification, and excretion; which four are often ranked as distinct functions.

106. "Animal life is composed of the organs of sense which receive impressions, of the brain which perceives them, reflects, and wills, of the voluntary muscles, and larynx, that execute this volition, and of the nerves which are the organs of transmission."—Bichat.

107. The organs of organic life are quite analogous in the lowest animals and plants; but each has peculiar characteristics. In animals a little higher in the scale, the common functions are performed by organs of greater complexity, and this complexity increases in the ratio of the development of animal life. Nevertheless, in most animals above the rudimentary there are the same subsidiary functions, whatever the difference in organization. There is in most, for example, the secretion of gastric juice, saliva, bile, &c., which subserve the common function of assimilation.

108. No organ of animal life, in a philosophical sense, is necessary to the individual. But, no part of the animal can exist without all parts of the organic system, or an equivalent; which is also true of the organic viscera. If the heart, for example, be wanting in the fœtus, the blood-vessels, as an equivalent, carry on the circulation.

109, *a.* The indispensable organs, of which no one can be abstracted without destroying the whole, are generally single in animals (§ 128). The same is true of plants, if we regard those organs which perform a common function in the light of a single organ. If the leaves fall spontaneously and abruptly in cold climates, no injury results to the plant, because it is passing into a torpid state.

109, *b.* Nevertheless, neither the action of the heart by which the blood is circulated, nor that of the lungs by which the blood is oxygenized, nor that of the brain by which the harmony of organs is maintained, nor that of the kidneys and skin by which redundancies are excreted, nor that of the liver by which bile is generated, nor that of any other compound organ, constitutes the real functions of life. They are only secondary or subordinate to others in which the absolute processes of life consist; and these are carried on by those extreme vessels which perform the immediate work of nutrition and vital decomposition. This is exemplified in the development of the ovum (§ 63–72), and throughout the vegetable kingdom. Indeed, life may be continued after removal of the brain merely by inflating the lungs; and could we substitute a machine for the heart, and the process of transfusion, both the heart and the lungs could be dispensed with for awhile.

These facts are important in showing the nature of the organic properties; how it is, and through what influences, the compound organs contribute, and are, each one, indispensable, to the life of animals; and that it is to the fundamental organization that we must look for all the absolute processes of life, and for the essential conditions of disease.

110. The parts by which life is carried on in the organic viscera are blended in the organs of animal life, and in those of the species.

111. The cerebro-spinal system is assigned both to animal and organic life. The sympathetic, like the cerebro-spinal, goes to the organic life of animals, and therefore pervades the organization in animal as in organic life (§ 110).

The cerebro-spinal nerves and the sympathetic interchange contributions, in all parts, by which important influences of the former are established in the organs of organic life (§ 452, &c., 500, 512, &c.).

112. Nevertheless, the cerebro-spinal system is especially designed for the uses of animal life; but an important final cause is answered in making it subservient to the common interests of the whole being (§ 455).

113. The sympathetic system is added especially to the organic life of animals, on account of the complexity of the organs, and to unite them in harmonious action, through circles of sympathy, and thus render them, each in its place, conducive to a common end. The cerebro-spinal system contributes to this result (§ 111, 112); and each system, unitedly, or independently, exerts special influences on the specific actions of organs, though these actions are carried on essentially through properties inherent in the several tissues (§ 226–233, 485½).

114. The most important common end (§ 113), as it respects the individual, relates to the functions of animal life. The organic system, then, in animals, though physiologically the most important, must be held subordinate to the uses of animal life. In plants, organic life is the whole being.

115. The foregoing union of organic life with all other parts (§ 110–114) establishes mutual relations between all parts of the organism, and brings the animal and sexual systems under the laws which appertain to the organic system (§ 455).

116. The same intimacy of parts confounds, in a degree, the distinction in the two lives (§ 115).

117. An important consequence of the foregoing vital union of organic with animal life (§ 110–114) is a general coincidence in the pathological as well as physiological condition of the whole. The diseases of each react mutually on each system of organs, each requires common methods of treatment, and remedial, as well as morbific, agents operate upon the universal body through any given organ (§ 455, 524, no. 1, 647).

Nevertheless, diseases of the animal organs more readily derange the organic viscera, than the latter the former; but, remedial agents operate far more powerfully in the opposite relation. The sympathies in the two lives, therefore, are not exactly reciprocal.

The foregoing apparent want of harmony in the physiological, pathological, and therapeutical relations of the two systems of life is reconciled by the consideration that nature has ordained, for the protection of the organs of animal life, that their wants shall be emphatically made known to those of the life on which they depend, and, on the other hand, their dependence on organic life has placed them under the special therapeutical control of that life; while the organic viscera being independent of the organs of animal life, therapeutical influences are but feebly propagated from the latter to the former. Such are the final causes in the great plan of Unity of Design.

118. The second class of organs and functions, which relate to the species, are divided into three orders: 1st, such as belong to the male; 2d, to the female; 3d, the functions relative to impregnation.

119. The several organs, and reproduction, belong both to plants

and animals. They are not necessary to the individual, though the whole organic system is necessary to their existence.

120. Although the organs of generation be not necessary to the individual, they exert many natural vital influences upon the animal functions. Their full development has also certain influences in organic life, which illustrate some important laws as to the vital properties. Their diseases may also give rise to great derangements of the organic functions. They fail earlier than the animal functions (§ 117, 578).

121. In the great sense of ultimate Design, all organic processes have for their final cause the development of the generative organs, and the production of germs; that similar beings may be maintained in one unvarying round of development and growth. Many beings die as soon as this end is attained, and return to the mineral kingdom to be again reorganized by plants, and again, and again, refitted for the nutriment of animals, and carry out, in both organic kingdoms, the final cause of their regeneration from the mineral.

122. It is necessary that the ovum of mammiferous animals should remain connected with the parent till the organs of organic life are developed. The law of dismemberment (§ 108, 109) does not apply to the ovum of oviparous animals, nor to the seed. They are endowed with the whole essential organization, and maturity of the vital principle, for independent life. The former gets its nutriment from the parent, till the organs are brought forth. The latter are supplied with nutriment from within themselves. In this case, also, the species are destined for great multiplication and distribution; in the other, their numbers and sphere are more circumscribed.

Nevertheless, the germ of all animals contains within itself the principle of carrying out the full development of a being similar to the parent, in all its complicated parts, which, however, have no rudimentary existence in the ovum. The progress, too, of fœtal development is always the same in each species, and every part is brought forward in the order of its importance in the organic life of the fœtus. It is the same in the vegetable kingdom.

123. The history of the seed and egg probably supplies one of the most remarkable illustrations of Design that can be found in nature; especially that of the seed. They are the only instances where the entire properties of life cease their ordinary operation without becoming extinct; and were it not for this interval of repose, the species would probably disappear; since, even if the properties of life carried out the development of the seed into the plant, the chances of preservation, and especially of multiplication, would be vastly diminished (§ 633).

124. Besides the foregoing general division of the organs and functions of living beings, another arrangement of the organs is founded upon the relation of special functions. Each component part, each group of organs, and the whole collectively, are replete with various and wonderful Design; each, and all, having peculiar ends, all conspiring to common ends, and in one harmonious Unity of Design maintaining the life of each other.

125. The following is

The Arrangement of Organs according to their relative Functions.

1. Nervous System.	Brain and cerebral nerves.		
	Spinal cord and its nerves.		
	Sympathetic ganglia and sympathetic nerve.		
2. Vascular System.	Heart and its Pericardium.	Direct circulatory organs.	
	Arteries.		
	Veins.		
	Lymphatics.	Destined for waste.	
	Lymphatic glands.		
	Lacteals.	Conveying the means of repair.	
	Lacteal glands.		
3. Digestive System.	Mouth, stomach, intestine.		
	Salivary glands and pancreas.		
	Liver.		
	Spleen.		
4. Respiratory System.	Larynx and vocal system.		
	Trachea.		
	Lungs.		
	Diaphragm.		
	Muscles of thorax and abdomen.		
5. System of voluntary muscles.			
6. Cutaneous System.	Derma, or main portion.		
	Papillary tissue.		
	Rete mucosum.		
	Epidermis.		
7. Urinary System.	Kidneys.		
	Ureters.		
	Bladder.		
	Urethra.		
8. Special Sensitive System.	Organ of hearing.		
	" sight.		
	" smell.		
9. Osseous System.	Bones.		
	Cartilage.		
	Ligaments.		
	Synovial capsules.		
10. Genital System.	Testes.	Formative.	Male.
	Ductus deferens.		
	Seminal vesicles.		
	Prostate gland.		
	Penis.	Copulative.	
	Muscles of perinæum.		
	Ovaries.	Formative.	Female.
	Fallopian tubes.		
	Uterus.		
	Vagina.	Copulative.	
	Hymen.		
	Clitoris.		
	Nymphæ.		
	Labia.		
	Constrictor vaginæ.		
	Mammæ,—accessory parts.		

126. The organic and animal functions are also naturally subdivided into,

1st. Those which operate from without inward, as in digestion; and,

2d. Those which operate from within outward, as in circulation, secretion, &c.

127. There are generally two sets of organs for the animal functions, having a harmony of action in their natural and healthy states.

128. When the organs of organic life are in pairs, as the kidneys, concerted action is not necessary; and here one organ may supply the place of both (§ 109).

129, *a*. The whole assemblage of organic viscera act together in concert; but the animal organs, as a general system, act more or less independently of each other.

129, *b*. The mutual relations which subsist between the various organs and their several functions are of two principal kinds; namely, the vital, and the mechanical.

129, *c*. The first class of relations may be distributed into three different orders. The first order consists of the relations between the organs of sense. The second order embraces those between the brain and voluntary muscles. The third order comprises the relations which are especially maintained by sympathy. It is the last subdivision, mostly, which is relative to our present subject. It concerns, therefore, the organization by which organic life is carried on in animals, and depends upon the nervous power in its function of sympathy, and upon a principle independent of the nervous power, called *continuous* sympathy, and which is probably also an important principle in plants (§ 111–113, 222, 233, 495–500).

129, *d*. The vital relations of a general nature evince the highest order of Design. They refer to the mutual co-operation of distinct systems of organs in the production of particular results, and of these various systems in the maintenance of universal life; while the several individual organs possess distinct and specific offices that are more or less dependent upon the principle of sympathy (§ 222–233, 455).

129, *e*. The sympathetic relations are most strongly pronounced among organs which concur together in the performance of special functions, as the circulatory, the digestive, the urinary, the sexual systems, &c. (§ 124). Other special relations subsist between the brain and the organs of animal life through the medium, in part, of the mental functions. Such is seen between the brain and voluntary muscles in the production of voluntary motion (§ 500, *d*). Thus, also, the senses aid each other; the sight being most independent. In this way, too, a concurrence is established between the teeth, muscles, eyes, nose, &c., in procuring food and supplying the stomach; each individual part having been also constituted with a reference to the nature of the food, and the mode of obtaining it (§ 323).

129, *f*. Plants are devoid of all that intimate association of parts which is determined by the nervous influence in animals, as well as by peculiarities of structure and special modifications of the common properties of life. But, a general relation of functions obtains to a certain extent in plants through the law of *continuous* sympathy, which, as I have endeavored to show, depends upon the organic properties (§ 498).

129, *g*. The sympathetic relations in organic life are of the very highest moment in medicine. Disease is propagated, is maintained, and removed, very greatly, through these natural relations.

129, *h*. The sympathetic relations are variously modified by disease, and are often more strongly pronounced than in health, though more or less diverted from their natural condition. Remedies also operate with greater effect through these modified relations, as well as through the greater susceptibility of the organic properties (§ 137, *d*). For the same reason, natural stimuli, as food, often prove morbific in diseased conditions (§ 152, *b*). The sympathies which grow out of morbific agents depend upon the natural principle, of which they are only modifications. And so of those which spring from remedial agents; these agents giving rise to greater influences in consequence of the morbid state of sympathy and of the organic properties, as well as in consequence of their own intrinsic virtues (§ 718, 901).

129, *i*. It appears, therefore, to be a most important law, that morbid states call into operation the function of sympathy among organs, which, in their natural state, manifest but feeble, and perhaps no direct relations whatever; and that, in consequence of morbid changes, remedial agents will operate sympathetically through the stomach, &c., upon remote parts, when they would have no such effect in the healthy state of the organs. This principle is demonstrated in every case of disease, and constitutes our first position against the humoral pathology, and the doctrine of the operation of remedial agents by absorption (§ 819, &c.). New vital relations being developed by disease, our remedies continue to operate through those acquired relations so long as they exist; while, also, the remedies themselves may institute analogous sympathetic relations, and thus simultaneously induce sympathetic influences of a salubrious nature in organs not morbidly affected (§ 74, 117, 137, 143, 155, 156, 387, 422, 514 *h*, 524 *d*, 525, 528 *c*, 733 *b*, 905, 980).

129, *k*. The *mechanical* relations are equally common to plants and animals. They are maintained by the motion of matter from one organ, or part, to another; as the transmission of blood from the heart through the blood-vessels, sap from the roots to the leaves of plants, food through the intestinal canal, urine from the kidneys to the bladder, and from the bladder through the urethra, &c. But, the movement of the matter is effected by the vital properties operating through the various organs.

130. Every part is a perfect labyrinth, anatomically considered. It is a labyrinth, also, of perfect designs; while the harmonious concurrence of these designs in the aggregate organs and tissues is too profoundly complex for any exact analysis. The deep intimacy of parts in each tissue corresponds with the union of the whole, with the dominion of common laws, and with that concerted action of all parts, which, in a popular sense, makes up the life of the organic being.

131. It has already been stated, that a knowledge of the minuteness of structure which is supplied by the microscope is practically useless, while the deceptions of that instrument have led to many important errors in physiology and pathology (§ 83). It cannot be depended upon, especially, in exploring soft structures. If it lead to unimportant facts, it is equally liable to betray us into error and fal-

lacious hypotheses. The whole history of that instrument, so far as physiology is concerned, has gone to confirm the foregoing conclusions, which were originally advanced in another work, and has conclusively sustained the opinion of one of the most profound observers of the present age. Thus:

"Authors," says Bichat, "have been much occupied with the intimate structure of glands. Let us neglect all these idle questions, in which neither inspection nor experiment can guide us. Let us begin the study of anatomy where the organs can be subjected to the senses." "No methodical mind will attend to the minute nature of the muscular fibre, upon which so much has been written. The exact progress of the sciences in this age is not accommodated to those hypotheses, which made general anatomy and physiology a frivolous romance in the last."

Microscopical information, so far as correct, goes to the amount of human knowledge, and to the perfection of science, though it may not contribute to useful ends. But experience shows us, that we may not depend, as it respects the microscope, upon the vision of others, especially where a high magnifying power is required. Each must observe for himself; and, as allowed by Ehrenberg, long practice, alone, can assure him of any general accuracy. The laborious student may attend to this accomplishment. But, *vita brevis, ars longa;* and he will be likely to live the subject of deluded sense rather than of enlightened understanding.

> "Enough is left besides to search and know.
> But knowledge is as food, and needs no less
> Her temperance over appetite, to know
> In measure what the mind may well contain;
> Oppresses else with surfeit, and soon turns
> Wisdom to folly, as nourishment to wind."—MILTON.

The following is another example in illustration of Milton's principle, and another instance* of the revolutionary spirit of the microscopic observers. I quote from Wagner's "Elements of Physiology for the *Use of Students.*"

"The study," he says, "of the VARIETIES OF FORM presented by the *seminal animalcules* ought not to be held as any trifling matter, or as tending to accumulate superfluous details. MOST IMPORTANT PHYSIOLOGICAL CONCLUSIONS may be BASED on the information thus acquired" (§ 83, *b*).

It is one of the few correct physiological conclusions to be found in the writings of Liebig, that

"The most exact anatomical knowledge of the structure of tissues cannot teach us their uses; and from the microscopical examination of the most minute reticulations of the vessels, we can learn no more as to their functions than we have learned concerning vision from counting the surfaces on the eye of a fly."—LIEBIG's *Animal Chemistry* (§ 83 *c*, 699 *c* and *d*).

When we consider, therefore, the constant deceptions of the microscope, especially in all explorations of soft substances, and the absolute uselessness of any knowledge it may convey as to the recesses of organization, it may be reasonably expected that the time is not

* See article on the Microscope, in *Medical and Physiological Commentaries*, vol. i., p. 699–712; and my *Examination of Reviews*, p. 6, 89; also, this work, § 515, *a*.

distant when all this lumber will be excluded from practical works on physiology, and turned, at least, into a channel by itself.

132. Each simple texture, when united into compound organs, has as much its own specific function as the aggregate compound. It is even more important, in a pathological sense, to regard the individual textures than the compound organ which they may form.

133, *a*. A consideration of the tissues in respect to their special character and functions, as well as their obvious anatomical differences, being of the very highest importance to the physiologist and physician, they can be only advantageously studied in these several aspects. Much must, therefore, be now anticipated as to what will be subsequently stated more circumstantially in regard to the properties and functions of life. The student must be prepared with that analysis before he can approach the tissues with any hope of enlightened knowledge. A simple statement of their apparent anatomical characteristics and relations, and of their products, would present a barren field. Nor is it alone their vital attributes which should most engage the attention of the medical philosopher, but he should be equally and simultaneously employed in learning how these conditions are modified in disease. Such, therefore, is my projected plan in relation to the tissues (§ 83, *c*).

133, *b*. Every distinct tissue, and often the same tissue as it occurs in different places and connections, and even the different parts of one and the same continuous tissue, possess, respectively, special modifications of the vital properties and functions. Upon these modifications depend the variety of the natural vital phenomena, as, also, very greatly, those which are morbid.

133, *c*. But there would be no disease were there not another important condition in the constitution of the vital properties; and this is their mutability. Its final cause is the well-being of organic nature; since, as organization changes in the progress of the plant or of animals to a state of maturity, so must there be an antecedent change in the properties which conduct the development of organs, &c. The same principle is displayed in gestation, lactation, &c. It is this, in connection with the susceptibility of the properties of life to the action of blood and other vital agents, which renders them liable to morbid changes when other causes operate. Such, therefore, is a necessary consequence of the final cause of the adaptation of the properties of life to the influence of salutary agents, and to the varying exigencies of organic nature.

Nor would there be any recovery from disease, but for the same mutability of the organic properties, and their liability to other changes when yet other causes operate (§ 177, &c., 901).

134. Owing to the peculiarities in the vital constitution of the different tissues, a common disease, as inflammation, is characterized by many peculiarities of symptoms, &c., in the several tissues, respectively. Differences also arise in their constitutional influences, and they may require corresponding variations of treatment (§ 717). This is even true of different parts of a continuous tissue, as the alimentary and pulmonary mucous membrane; where inflammation of this membrane in the nose, larynx, trachea, lungs, fauces, stomach, and intestines, is distinguished by almost as striking peculiarities in the vital signs, and in their constitutional influences, as are the physiological

functions of the different compound organs which it traverses (§ 740, 752–754, 780, 783).

135, *a*. The special modifications of the vital properties in different parts of one and the same continuous tissue is often strikingly denoted by the character of the natural product of the several portions, respectively; as in the tissue last mentioned. Nothing, for example, can be more unique than the gastric juice, a product, no doubt, of all animals, while it can be generated by nothing but the mucous tissue of the stomach. Again, in the lungs we meet with this tissue performing the office of excretion; being the only example in which an organ eliminates truly effete matter from venous blood. And here an important analogy occurs to show that the elaboration of carbon is a vital process (§ 316, 419, 827 *b*). In the uterus, the same membrane appears as an organ of excretion in relation to the arterial blood, but for the uses of the uterus alone; nor is there any thing else in nature that is capable of generating a similar product. But, in all the cases, the analogy which is indicated by the coincidence of anatomical structure is farther confirmed by the universal production of mucus by this remarkable tissue.

135, *b*. All the foregoing is delicately exemplified by the great variety of formations which are generated by the granulations that spring from ulcers; since, although in all the cases the granulations appear to be identical in character, we know from their production of parts analogous to such as had been removed by the ulcerative process, that, in every instance, the granulations must have been endowed, respectively, with specific modifications of the organic properties (§ 733, *c*).

136. In consequence, also, of the foregoing peculiarities of vital constitution, every tissue, and often continuous parts of a tissue (as in the last example), possess natural stimuli peculiar to each, and in certain relative quantities. Each part, indeed, has as many stimuli as it possesses peculiarities of properties and functions. Owing, also, to the general coincidence in the vital constitution of all parts, there are certain general stimuli adapted to the whole, especially the stimulus of heat. The blood has been regarded as a universal stimulus; but, it is only so in relation to the sanguineous system. This fact, it may be now remarked, evinces, what is shown by diseases, a near identity in the vital constitution of all that part of the arterial system which conveys red blood; while, on the other hand, the difference between arterial and venous blood shows a difference in the organic properties of the arterial and venous systems. This has its deep foundation in the whole physiological condition of man and animals, and I may also add, in the whole vegetable tribe (§ 847, *c*). While every surface has some secreted product adapted to its own special modification of irritability, many of these products may be offensive to other parts. Again, the special irritability of one part may be exactly suited to some product of another part, and this may or may not be a natural vital stimulus, and perfectly inoffensive, to the second part, while it may excoriate all other parts. Bile, for instance, is the natural stimulus of the intestine, but will injure other parts. Venous blood is harmless in the veins, and excites them, more or less, to a contractile action; but is rapidly fatal within the arteries (§ 849). Urine is the natural stimulus of the bladder, but will excoriate most other parts (§ 74, 188½ *d*, 650, 847 *e*).

137, *a*. In this relative sense the animal is filled with poisons; each one of which, however, in its proper place, is not only inoffensive, but indispensable. Here is the principle.

137, *b*. It is, also, upon the foregoing organic constitution of different parts, and which gives rise to a mutual relation of the different vital agents and products of organs and of the different parts of the organism, that the differences in the effects of remedial as well as morbific agents upon different parts is essentially founded. Wine inflames the mucous tissue of the bladder, &c., but may be good for the stomach. Tobacco smoke is inoffensive when inspired in the ordinary mode; but it is a violent poison when introduced within the alimentary canal. Other agents affect the stomach, or intestines, or liver, or uterus, or bladder, &c., each organ more than the others, and more than other parts (§ 233¾, 772 *c*, 838.)

137, *c*. From not duly regarding these important facts, or from an ignorance, or a disregard of physiology, many agents which have a specific relation to the vital constitution of some tissue in a particular part of the body, as the mucous, for example, are supposed to have the same relation to the tissue in all other parts. Hence the oil of turpentine, copaiva, naphtha, &c., have been abortively or injuriously employed in pulmonary catarrh, phthisis even, diarrhœa, dysentery, &c., mostly for the reason that they exert a specific effect upon the mucous tissue of the urinary organs.

This great law of adaptation is so universal as to extend throughout the whole domain of medicine, reaching as fully into pathology and therapeutics, as it is conspicuous in physiology. If the blood be rendered morbid by morbid states of the solids, it never becomes morbific, since there is a progressive adaptation of the vital changes in the solids to such as the solids induce in the blood. And so of various morbid secretions in relation to the parts by which they may be produced. These results, in which the vital properties of the solids are always concerned as the primary cause, are founded in an all-pervading law of the animal economy, and by which, and which alone, nature is enabled to throw off disease (§ 524 *d*, 944 *c*).

137, *d*. Again, it is one of the most important laws in medicine, that the susceptibility of tissues and organs to the action of remedial agents is more or less affected by disease. Many agents which operate powerfully in certain morbid states, and in certain doses, both locally and sympathetically, may be perfectly inert in the natural states of the same organs. And so of the natural agents of life. The greatness of the effects, also, will depend very much upon the nature and intensity of disease. The same principle applies to the impressions which are made by many remedial agents upon existing states of disease, or upon organs in their state of integrity; by which the diseased or healthy parts are increased in their susceptibility to the subsequent action of the same or other remedies, or to morbific causes (§ 143, *c*).

137, *e*. It is, therefore, one harmonious system of laws throughout. Were it, indeed, otherwise, remedial agents could have no existence, and disease, of course, could receive no help from art. These, also, are the beginning of a long series of facts, which show us that the effects of all agents, whether morbific or remedial, may be traced to the peculiar impression which they exert upon parts with which they come in contact; and by which, also, we overthrow the whole system

of chemical physiology, the humoral pathology, and the doctrines of debility, and of cure by the absorption of remedies (§ 847, *e*).

138. The natural modifications of the vital properties and functions, or the special vital constitution, of any particular tissue, or parts of a continuous tissue, and, therefore, their special modifications in any given disease, conform to the general nature of the complex organ of which the tissue may form a component part.

Certain tissues of a compound organ are far more liable to disease than its other tissues. Thus, the mucous tissue of the stomach is quite liable, the serous rarely, and the muscular more rarely (§ 764, *a*).

139. Disease of any particular tissue, or parts of a tissue, is apt to be most severe, in its local and general character, according to the importance of the functions of the *compound organ* of which it may form a component part. This, however, is less true of the constitutional influence, than of the local intensity of disease.

140. The sympathetic influences of disease are also greatly determined by the nature of the affection, especially the constitutional effects. Inflammation of the serous, venous, and ligamentous, tissues, disturb the constitution far more than the same degrees of inflammation affecting the mucous, arterial, and muscular, tissues. But much, also, as already said, will depend upon the nature of the compound organ with which the tissue, or part of a continuous tissue, may be associated; though sometimes, where the compound organ is comparatively unimportant, inflammation of one of its tissues may give rise to great constitutional disturbances. Such, for example, is true of some inflammatory affections of the mucous tissue of the throat; and no disease is more intractable than laryngitis. Much, also, will often depend upon the special modification of disease; as in acute articular rheumatism (§ 525–530).

141, *a*. Tissues of the same organization are most allied in their vital properties, and hence are most liable to sympathize with each other in their diseases.

141, *b*. When one tissue of a compound is diseased, the properties and functions of the others are more or less disturbed; though the primary disease is not apt to be propagated to them from the tissue first affected. It continues rather in the tissue first invaded. Inflammation, for example, beginning in the mucous tissue of the stomach, will extend along that tissue, so far at least as its connection relates to the stomach, without being often propagated to the other tissues of the compound organ. This principle has a broad foundation, and is owing to the general coincidence in the vital constitution of all parts of the same tissue, and to the differences between the vital states of that and the associated tissues. Exceptions, however, occur more frequently in some parts than in others; as in the lungs, where pleuro-pneumonia is not unfrequent. Nevertheless, in these cases, the simultaneous affection of two distinct tissues of a compound organ may be rather owing to a general predisposition effected by some remote cause, than to morbific influences exerted by one tissue upon the other. In other cases, especially of specific inflammation, the disease is propagated directly from one tissue to another, as in scrofula, rheumatism, &c.

142. For reasons stated in § 133–136, morbific agents may readily excite disease in one part of a continuous tissue when it would have

no effect on another part of it; or may operate more profoundly on one part than on another. And this holds true of the action of remedial agents. The same is also true of the sympathetic influences which may be exerted by disease; and a like principle applies to certain sympathies that fall upon special parts which are immediately continuous with each other, but which are determined, also, by certain special vital relations of the different parts. Thus, the vital relations of the tongue to the alimentary canal being far greater than to the lungs, and as the canal readily sympathizes with other chylopoietic viscera, the tongue is far more sensitive to abdominal than to pulmonary derangements (§ 129 *c*, *i*, 689 *i*).

143, *a*. Again, there may be varying susceptibilities of the different parts of a continuous tissue (arising from numerous causes not positively morbific), when the same morbific, or remedial, cause will affect one part or the other more in conformity with the acquired susceptibilities, than with the natural modifications, of the vital properties in the several parts, respectively. This is also more applicable to the tissue as it occurs in compound organs not anatomically connected, and to tissues which differ in their organization (§ 783).

143, *b*. Hence it follows, that, if all the organs be rendered preternaturally susceptible, a general explosion of disease may follow the operation of some cause, which, in sounder health, would be harmless. Under these circumstances, however, disease is most apt to spring up more or less sympathetically, and successively, in one part after another, till all parts may ultimately be brought into some, though variable, forms of disease (§ 514 *h*, 660, 666, 905). But, in these cases, it generally happens that some of the morbid states abate, or subside, as new ones come forward, the new ones, perhaps, subduing sympathetically the older in the series (§ 804, 905). The system, therefore, is rarely universally invaded by disease, except in idiopathic fever (§ 148, 783).

Nevertheless, it probably does not often, if ever happen, except in fever, that the primary is the efficient predisposing cause of universal disease, but that disease of one organ proves the predisposing of disease in another; and as one organ after another becomes affected in this manner, they co-operate together in rendering other parts susceptible of disease (§ 644, &c.).

143, *c*. In proportion, therefore, as the susceptibility of the system at large is increased by morbid changes, or predisposed by morbific influences, so, in a general sense, will the alterative action of remedial agents be felt in a corresponding manner (§ 137 *d*, 152 *b*, 715). By the law of adaptation as set forth in the *Medical and Physiological Commentaries* (vol. i., p. 649, 653–655, &c.), and in various parts of the present work, the sympathetic influences of any local disease which is felt by distant organs modifies the vital states of those parts in a manner that institutes harmonious relations to the part more profoundly affected; and thus remedial agents will extend their salutary alterative action to such distant parts, and render them the source of salutary effects upon the essential seats of disease (§ 74, 80, 117, 129 *i*, 133–137, 143, 155, 156, 169 *f*, 387, 399, 422, 514 *h*, 524 *d*, 525, 528 *c*, 638, 649 *d*, 811, 848, 902 *f*, 905). When the whole system is invaded by disease, as in idiopathic fever, the alterative action of remedies is felt over the universal body (§ 148, 152 *b*, 222–232, 500,

904 *d*). It is owing, also, to the same law of adaptation, the same universal, however partial modifications of the vital states which local diseases often induce, that parts remote from the direct seat of disease are protected against all morbific effects from any changes which the blood may undergo as a consequence of morbid action (§ 845, &c.).

Independently, however, of any increased susceptibility of organs, the action of numerous agents upon the stomach may determine influences upon distant parts whose natural state is unimpaired, and these influences may become the source of other impressions upon other parts. Circles of sympathy may be thus established throughout the system, by which all parts shall concur in the relief of the gastric irritation which had given origin to the whole. In this manner a cathartic or an emetic may bring the whole organism to bear with favorable influences upon some slight inflammation of the throat which had exerted no modifying effects upon other parts (§ 514 *h*, 692 *a*, 902 *g*).

143, *d*. Again, there are some remedial agents possessing general vital relations to the whole body, especially the several preparations of mercury, and others whose specific relations are more limited, like cantharides, which will affect profoundly the entire organization, or certain individual parts, and alter the condition of their vital states, in the most healthy conditions. These agents, therefore, approach most nearly the truly morbific ones, while they possess the grand characteristic of the Materia Medica of instituting morbid changes which are of transient existence.

144. Many acquired conditions may be transmitted from parents to child, and they then form a constitutional predisposition to disease; being a permanent and more or less universal modification of the vital properties (though of some parts more than others), which does not properly belong to them; as in scrofula. Here, the absolute remote cause has operated upon the ancestor (§ 75–80, 563).

145. Subjects thus constituted (§ 144) are liable to morbific influences which the more natural do not feel; and such causes as would produce in the natural subject common inflammation of the nose, trachea, &c., will excite scrofulous inflammation in the lungs of the acquired constitution (§ 650, 659).

146. Hereditary predisposition to disease manifests itself in certain tissues and organs more than in others, according to the nature of the transmitted constitution (§ 143, *a*).

147. Sympathetic diseases may spring up in unusual constitutions, when they would not in the more natural. Thus, in certain hereditary conditions, indigestion gives rise to scrofulous, rheumatic, and gouty inflammation of parts distant from the chylopoietic viscera. The same principle is also in operation when the vital constitution of parts is modified by habits, climate, age, the development of the generative organs, &c. (§ 542).

148. Certain causes appear to be capable of affecting, directly and indirectly, all the tissues of the body, as in idiopathic fever; though, in these cases, the primary morbific effect is on particular parts, from which it is disseminated by sympathy over the entire body (§ 649, 665, 666, 760). In these cases, however, it appears not to be a positive state of disease in the part upon which the morbific agents may exert their primary effects, as on the mucous surfaces, which brings the rest of the system into a predisposition to disease; but a predis-

position being established in those primary parts, the impression is of such a nature as to be propagated sympathetically over the universal body; just as when many remedial agents acting upon the mucous surface of the stomach exert powerful influences upon remote organs, but without inducing disease in the gastric mucous membrane. It is, therefore, in idiopathic fever, as well as in numerous local affections, that the parts on which the morbific agents exert their direct effects may not manifest any signs of disease till the explosion of fever takes place; or as when pneumonia, or catarrh, are induced by the action of cold upon the skin; while it often happens that the parts thus originally, but imperceptibly impressed, become sympathetically the seats of absolute disease by the reacting influence of the diseases which had been sympathetically produced through these parts. Very complex circles of sympathy may thus become established. These general affections may be also broken up by the action of a single remedy, as by an emetic, or mercury, &c. (557, 559, 712).

149. It is a great and important law, resulting from the physiological considerations now made (§ 133–148), that morbific causes, external or internal, determine disease upon the tissues of one compound organ or another, according to the particular virtues of the morbific causes, and in accordance, also, with the natural modifications of the vital properties in every part, and the susceptibilities which they may acquire from other causes (§ 642 *b*, 722 *d*, 725, 794, 795, 808). Hence it follows that many of the natural stimuli of life may become morbific.

150, *a*. It is a great fundamental law, that a general coincidence exists between the natural susceptibilities of the properties of life to their ordinary stimuli (§ 136), and to those of a morbific, and of a remedial, nature, according to the natural modifications of the vital properties, whether in a general sense (§ 148), or in their relation to particular parts (§ 136); the influences produced conforming, of course, to the natural modifications of the properties of life and the special virtues of the several agents, though modified by the transient or permanent influences which spring from other sources, especially from disease (584, 644–674, 772 *c*, 826, &c., 847 *e*, 904).

Such is the inevitable result of the constitution of the properties of life (§ 177). It is, as it were, the great focal point from which all diverges that is embraced in medicine; the bond which unites every branch of the science.

150, *b*. All that is here said, and in § 149, is equally applicable to the nervous power, in all its modifications, as an agent in the production and cure of disease, as to agents of a physical nature (§ 222–233$\frac{2}{4}$, &c.).

151. It is through the foregoing law (§ 150) that the natural stimuli of life maintain all parts in their precise conditions; through which, also, morbific agents alter those conditions in certain uniform ways, and through which remedial agents establish certain other changes which enable the properties and actions of every part to return spontaneously to their natural states. The law involves an immense range of facts in physiology, pathology, and therapeutics, and groups many other fundamental principles. It should be the point of departure in all our medical researches and reasonings; for it is, as it were, the polar star which will guide us safely upon our difficult and dangerous voyage (§ 794, 795, &c.).

152, *a*. It follows, therefore, from § 150, 151, that the operation of all things upon the living organism, whether food, heat, cold, blood, poisons, the nervous power, or remedies for disease, is upon one common principle, which is relative to the natural constitution of the organic properties. Food stimulates the stomach, and throws a genial sympathetic influence over the whole organism, warming the cold surface as soon as it enters its appropriate receptacle; blood maintains, in the same way, the actions of all parts; poisons and morbific agents, put into the stomach, affect the vital properties of that organ injuriously, when, unlike the case of food, pernicious sympathetic influences are transmitted to other parts, or the same food, in excess, may do the same. We then introduce into the same organ another class of morbific agents that are less profound in their operation, and which prove remedial in certain doses, and therefore establish, through the same principle, a salutary change in the same properties which other poisons had affected injuriously (§ 638, 642 *b*).

152, *b*. It is also worthy of repetition, that such is the analogy between morbific and remedial impressions, that the organs which sustain the former are thus rendered susceptible of the latter, when they might be otherwise insensible to the same remedial agents, in their appropriate remedial doses. Such is the harmony of the laws of nature; such their great final causes (§ 524, no. 3, *d*). For the same reason, also, many of the natural agents of life, such as the ordinary kinds of food, may be intensely morbific in most of the diseases of man (§ 849). Or, again, the agents which heal in their remedial doses may establish severe forms of disease when administered in health.

153. Through the law of development, the tissues undergo natural modifications in their structure and vital endowments at many periods of life. In infancy, the organs are imperfectly developed, though the properties and functions of organic life, unlike those of animal life, are strongly pronounced in many of the viscera. A relation obtains, however, in organic life, between the properties and functions and the relative size of organs (§ 159).

In childhood, there is another well-marked change. In adolescence, another; when the organs become mature. In old age, another; when life is naturally on the decline.

154. The foregoing stages of development (§ 153) are not sudden, but gradually progressive.

155. The changes of organization (§ 153, 154) are preceded by corresponding changes in the vital properties, upon which the former depend (§ 445, *f*). This principle, too, like all others which relate to organic life, whether in health or disease, is universally true under any given combination of circumstances. It is true of the development of all tissues and all organs, and all other products, from the beginning of conception to the end of life. Hence, also, the variety in the remedial or morbific virtues of many plants, at different stages of their growth. As structure varies, the vital properties have undergone modifications, in conformity with that order of Design which was instituted, that where one specific end is accomplished, and others are to be fulfilled, the powers by which these final causes are to be accomplished shall have their necessary adaptations. And while, also, the vital properties, under all their natural modifications, are so constituted as to receive certain exact impressions from the natural stim-

uli of life, that vital actions may be determined according to the purposes ordained, so also will morbific and remedial agents be varied in their influences (§ 129 *i*, 387, 980).

156, *a*. The foregoing variations (§ 153–155), therefore, give rise to new dispositions to disease in many parts, and are productive of modifications of former diseases, or the latter disappear. This, as we have seen, is a necessary consequence of the physiological changes, since the same properties which carry on nutrition and growth carry on all diseases. The relations of vital and morbific agents move on, *pari passu*, with the natural changes in the properties of life; and remedial agents undergo corresponding modifications of action.

156, *b*. The great law of adaptation is forever present to the eye of the naturalist; and when the same subjects are contemplated in a moral sense, the same evidences of Design meet him at every glance of the mind. Take an example of a compound nature, a universal physiologico-moral phenomenon in which our present topic is involved. Thus, no sooner was man created than he was doomed to obtain his subsistence by the sweat of his brow. Roots, grains, fruits, &c., were, therefore, as far as the wants of animals would allow, created mostly in an unedible condition, but rendered susceptible of the requisite improvement by cultivation; and to carry out the great purpose, the nature of soils, air, water, &c., were made subservient (§ 74, 80, 117, 137, 143, 155, 169 *f*, 266, 384, 385, 387, 399, 409 *f*, 422, 514 *h*, 524 *d*, 525, 526 *d*, 528 *c*, 638, 733 *b*, 847 *g*).

157. Organs are softest and most fluid at the beginning of their development, and increase, progressively, in density through life. The animal ovum is scarcely more than an organic fluid.

158. Vascular action is promoted by the greater fluidity of organs, and *vice versa* (§ 142). Inflammation is in part, therefore, more intense and rapid in infancy and childhood than at later periods, which, with other causes, gives rise to the necessity of great promptitude of remedies. Other causes attending the vital conditions of old age render equally important a decisive treatment of the severe diseases that may befall that age (§ 574, &c., 1009, &c.).

159. The proportional size of organs varies at different stages of life. The cerebro-spinal system, for example, is largest in childhood. Hence a greater development of the organic properties in those parts, and a greater consequent liability of the brain to inflammatory and congestive affections, and to hydrocephalus. The large proportional size of the nervous and arterial systems affects the physiological and pathological condition of all other parts; giving activity to nutrition, and susceptibillty and intensity to disease.

The glandular tissue of the liver has the largest proportional size in infancy; but not so the venous system of the liver. Hence, again, the glandular function of that organ is especially liable to derangement in infancy, and its venous tissue to congestion at more advanced ages.

It is also important to understand, that the veins, in a general sense, "have a real inferiority as it respects the arteries, during the first periods of life."—Bichat. There are some exceptions, especially in the brain.

160. What has now been said of the modifications of the vital constitution of different tissues and organs may be illustrated by the rel-

ative liability of different tissues, and parts of common tissues, to some given disease, by the relative danger of that disease as it may affect the different parts, and by the effects of some remedial agent upon the various parts, respectively. The remedy may be loss of blood, and the supposed disease inflammation. The statement may be conveniently made in a tabular form, while, also, it may be converted to practical uses (§ 711).

161. The tables are intended in a general sense, and suppose the constitution to be naturally sound. If hereditary predispositions to disease exist, as in scrofula, or if the constitution be affected by intemperance, or by previous diseases, &c., the order of liabilities to inflammation, &c., as marked in the first table, will be more or less affected. In the scrofulous constitution, for example, instead of the mucous, the lymphatic tissue may be most liable.

162. The tables will be more or less modified by age. Thus, the veins of the pia mater are more liable to congestion in infancy and childhood than any other part of the venous texture. This liability afterward decreases, and returns at the age of fifty and upward, resulting in cerebral hemorrhage (§ 805).

PHYSIOLOGICAL AND PRACTICAL SUGGESTIONS.

Tissues most liable to disease, especially to inflammation, in the order of arrangement:

TABLE I.

1. Mucous.
2. Venous (*venous congestion*).
3. Cellular.
4. Serous.
5. Ligamentous and dermoid (*fibrous*).
6. Glandular.
7. Lymphatic.
8. Nervous.
9. Synovial.
10. Periosteum (*fibrous*).
11. Osseous.
12. Tendons, cartilage, dura mater, and pericardium (*fibrous*).
13. Muscular.
14. Arterial.

TABLE II.

1. Mucous texture	of the nose.	
	" lungs, fauces,	
	" eyes.	
	" small intestine,	Ilium, Jejunum, Duodenum.
	" stomach.	
	" large intestine.	
	" uterus and vagina.	
	" bladder.	

2. Venous texture (forming, mostly, venous congestion)	of pia mater, in infancy and childhood.
	" liver.
	" small intestine.
	" pia mater of adults.
	" rectum (*piles*).
	" uterus (*phlebitis*).
	" lungs (*congestive asthma*).
	" lower extremities (*varix*).
	" spermatic cord (*circocele*).
3. Cellular texture . . .	sub-cutaneous.
	of the lungs.
	" pia mater.
	" voluntary muscles.
4. Serous texture	of the lungs.
	" parietes of thorax.
	" parietes of abdomen.
	" liver.
	" small intestine.
	" large intestine.
	" heart and pericardium.
	" cerebral ventricles.
	" kidneys.
	" stomach.
5. Glandular texture . . .	lymphatic glands.
	mammæ (*puerperal*).
	salivary glands.
	liver.
	testis.
	lacteal glands.
	kidney.
	thyroid gland (*goître*).
	thymus gland.
	pancreas.
6. Lymphatic texture . .	of the lower extremities.
	" upper extremities.
	" uterus (see *Comm.*, vol. ii., p. 470).
	others rarely.
7. Fibrous texture	ligaments.
	dermoid.
	periosteum.
	cartilage.
	tendons.
	pericardium.
	dura mater.
8. Nervous texture . . .	brain.
	nerves.
	ganglia of sympathetic.
	spinal cord.
9. Synovial texture . . .	of the knee-joints.
	" ankle.
	" joints of upper extremities.
10. Osseous texture	spongy bone.
	solid bone.

11. Arterial texture . . . . { of the brain.
arch of aorta.
" extremities.
rare in other parts.

TABLE III.

Relative danger of high inflammation affecting the tissues of different organs, according to the order of arrangement:

1. All textures of the brain.
2. All textures of the heart and pericardium.
3. Venous and lymphatic textures of the womb, iliac and other veins.
4. Peritoneum of abdomen (*puerperal women*).
5. Serous membrane of small intestine.
6. Veins of the liver (*venous congestion in congestive fevers*).
7. Parenchyma of lungs.
8. Glandular texture of liver.
9. Mucous texture of small intestines.
10. Mucous texture of stomach.
11. Serous texture of large intestine.
12. Textures of kidney.
13. Mucous texture of large intestine.
14. Serous texture of lungs and thorax.
15. Serous texture of liver.
16. Serous texture of abdominal parietes (*common inflammation*).
17. Veins of lungs (*low, or sub-active, forming congestive asthma.* See *Comm.*, vol. ii., p. 494).
18. Textures of bladder.
19. Mucous texture of uterus.
20. Ligaments.
21. Bone and cartilage.
22. Lymphatics of extremities.

TABLE IV.

Tissues which require the greatest extent of general blood-letting, when affected with high inflammation,—according to the organs in which they are associated, and in the order of arrangement. The remedy is supposed to be applied early.

1. All textures of the brain.
2. All textures of the heart and pericardium.
3. Serous texture of small intestine.
4. Peritoneum of abdomen (*in puerperal women*).
5. Parenchyma of lungs.
6. Serous texture of stomach.
7. Serous texture of large intestine.
8. Veins and lymphatics of uterus. (*Early.*)
9. Serous and glandular texture of liver.
10. Venous texture of liver. (*Sub-acute, congestion in congestive fever. Often more largely.*)
11. Mucous texture of small intestine.
12. Uterus.
13. Textures of kidney.

14. Mucous texture of stomach.
15. Mucous texture of large intestine.
16. Serous texture of lungs and chest.
17. Serous texture of abdominal parietes. (*Common inflammation.*)
18. Ligaments. (*Often more largely.*)
19. Bladder.
20. Mucous texture of bronchiæ.
21. Mamma, testis, parotid gland.
22. Absorbents of extremities.

163. In the treatment of disease, therefore, we should consider the precise pathology of each affected tissue, the natural vital peculiarities of the affected tissue in the compound organ, its general character as well as that of the compound organ in the animal economy, the influences which its morbid state exerts upon the other tissues in a compound organ, its own morbific influences and the combined influences of the compound organ upon other parts, and how the remote sympathizing parts may react, or shed an influence on yet other parts. And then follows not only the general plan of treatment, but all that nice discrimination of cathartics, emetics, alteratives, and other groups of agents possessing, in their individualities, respectively, analogous virtues, their combinations, alternations, precise dose, frequency of repetition, &c. (§ 675, 685, 686). The same variety of considerations are to be made when the condition of diseased parts may undergo changes, favorable or unfavorable, from the operation of remedial agents.

We are mostly assisted in the foregoing inquiries by comparisons of the morbid with the natural vital phenomena and physical products of each part, and the whole collectively. We also acquire much of our knowledge of the natural constitution of individual parts by observing the deviation of their phenomena when acted upon by morbific or remedial agents. The phenomena are then more strongly pronounced than in health, or new ones are developed. Indeed, it is sometimes through morbid conditions only that we acquire a knowledge of some of the important physiological conditions; as, for example, the existence of common sensibility in all parts. Hence a corollary, that none but an observer of disease can expound the natural conditions and laws of life (§ 685, 686, 848).

THIRD DIVISION OF PHYSIOLOGY.

PROPERTIES OR POWERS OF LIFE.

164. A VITAL, or peculiar governing principle or power, in organic beings, has been recognized by all the most distinguished medical philosophers at all ages of the science. It is the fundamental cause of growth, nutrition, and of all other phenomena of organic beings. It is, in all but the vulgar acceptation, synonymous with the term *life*; and *life*, therefore, is a *cause*, and not an *effect*, as has been assumed by many distinguished physiologists.

165, *a*. "Until it is proved," says Andral (the restorer of the humoral pathology), "that the forces which, in a living body, interrupt the play of the natural chemical affinities, maintain a proper temperature, and preside over the various actions of organic and animal life, are analogous to those admitted by natural philosophy, we shall act consistently with the principles of that science, by giving distinct names to those two kinds of forces, and employing ourselves in calculating the different laws they obey."—ANDRAL'S *Pathological Anatomy.*

And, to the same effect, the distinguished organic chemist, Liebig, the chief of the school of pure chemistry (§ 4½):

"There is NOTHING to prevent us from considering the VITAL FORCE as a PECULIAR property, which is possessed by certain material bodies, and becomes sensible when their elementary particles are combined in a certain arrangement or form. This supposition takes from the *vital phenomena* nothing of their wonderful peculiarity. It may, therefore, be considered as a RESTING POINT from which an investigation into these phenomena, and the LAWS which regulate them, may be commenced; exactly as we consider the properties and laws of LIGHT to be dependent on a certain *luminiferous matter* or ether, which has no farther connection with the laws ascertained by investigation."—LIEBIG'S *Animal Chemistry.*

So, also, Carpenter, Roget, and other eminent chiefs of the physical school (§ 64).

And thus, the eminent Müller, who leads in the school of chemico-physiology:

"The only character that can be possibly compared in organic and inorganic bodies, is the mode in which *symmetry* is realized in each." "Whether the vital principle is to be regarded as imponderable matter, or as a force or energy, is just as uncertain as the same question in reference to several phenomena in physics. Physiology, in this case, is not behind the other natural sciences; for the *properties of this principle* in the functions of the nerves are nearly as well known as those of light, caloric, and electricity, in physics."—MÜLLER'S *Physiology.*

Finally, we have the pure vitalist, teaching the same doctrine; though, with greater consistency. Thus:

"Physiology," says Bichat, "would have made much greater progress, if all those who studied it had set aside the notions which are borrowed from the accessory sciences, as they are termed. But, these sciences are not accessory; they are wholly strangers to physiology, and should be banished from it wholly." "To say that physiology is made up of the physics of animals, is to give a very absurd idea of it. As well might we say that astronomy is the physiology of the stars."—BICHAT'S *General Anatomy, &c.*

Tiedemann, too, was right in saying that,

"All the qualities of organic bodies should be looked upon as the effects of the vital powers. Even those phenomena seen in them, which they exhibit in common with inorganic bodies, undergo modifications of their specific action, and should be considered subordinate to the vital powers."—TIEDEMANN'S *Physiology, &c.*

There is not, indeed, in the whole range of medical literature, one author, however devoted to the physical and chemical views of life, who does not evince the necessity of admitting a governing *vital prin-*

ciple as a distinct entity, distinct from all other things in nature. I say, there cannot be produced one author of any consideration, who does not summon to the aid of his discussion *a vital principle* whenever he touches upon the abstract phenomena of life. And this I have abundantly shown by an extensive range of quotations in my various publications.

165, *b*. We are constantly asked, how we know the existence of the vital properties or powers? Again, I say, precisely by the same means as the advocates of the chemical and physical philosophy of life defend their knowledge of the forces which govern the inorganic world. The question is important, as implying that physiologists either do not arrive at their knowledge of causes through their effects, or, that there is nothing different in the phenomena of organic and inorganic beings. What would the metaphysician say, were we to ask him for any other demonstration of mind than its manifestations; or the mechanical or chemical philosopher, should we demand any other evidence of gravitation, magnetism, chemical affinity, &c., than the effects which they supply? And do we not distinguish one from the other, and regard them as wholly distinct forces, by the difference in their effects? The proof is clear and tangible, in all the cases. Where the results of power differ so materially from each other, it is as good a ground of argument, that the phenomena depend upon specific powers in one case as in the other; and, if it be "a cloak of ignorance" in either case to *assume* the existence of powers, it must surely appertain to him who attempts an explanation of the phenomena by assuming forces with which such phenomena have no known connection (§ 175, *bb*).

166. Many of the eminent ancient physicians considered the vital principle an intelligent agent; and even Hunter has been supposed, though erroneously, to have been of that opinion. Some distinguished physiologists, of the present day, are inclined to regard the soul as that agent. Others confound it with the Deity;* while yet others, confounding the Deity with Nature, fall into a labyrinth of absurdities.† Others suppose the vital functions alone to constitute life.‡ The ancient physicians generally distinguished the vital principle from the soul, and regarded both as immaterial (§ 175 *d*, 350¾ *k*).

167, *a*. The vital principle was early known under the names of *Anima* and *Callidum Innatum.* It was greatly lost sight of in the "dark ages," but reappeared among the earliest restorers of learning, when it took the name of *Anima Vegetans,* as significant of its organizing power in plants and animals. The eccentric philosopher, Paracelsus, substituted the name of *Sidereal Spirit,* to suit his dogmas of planetary and demoniac influence. Then came Van Helmont, with his inovation of a *Spiritus Archæus,* an immaterial principle, which he located in the upper orifice of the stomach. It presided over the body in a general sense, and had under its command several subordinate spirits (one for each organ), to execute the orders of the great spirit. But, like Paracelsus, he expounded much of his physiological results upon chemical principles, and had no definite conceptions of the office of his Archæus. Stahl followed Van Helmont with his *Rational Soul,*

* See my article on the "Vital Powers," in *Medical and Physiological Commentaries,* vol. i.; and my "*Essays on the Philosophy of Vitality.*"

† See my "*Examination of Reviews,*" p. 43.

‡ *Comm., ut supra.*

and Lord Bacon had entered the field in defense of a vital principle. Then came Haller, with his great philosophical and practical distinction of the *Vis Insita* and *Vis Nervea*. Here we enter into the midst of the profound theories of irritability and sensibility, which had been suggested by Galen (§ 476, *b*). Glisson, too, had forced his way into the laws of irritability; and Baglivi had already dealt his fatal blows upon the humoral pathology. We may, therefore, date the progressive and substantial foundation of vitalism and solidism from Baglivi to Haller; a period of about one hundred years.

167, *b*. Whytt modified the Stahlian doctrine; and the visionary Des Cartes led the way in rejecting altogether, for awhile, the vital powers, in which he was aided by the hypothesis of a nervous fluid, which appeared about his time. The doctrine then followed, as a consequence, that matter acquires vitality in virtue of a peculiar organization, and this became an easy step to the atheistical doctrine of spontaneous generation. Then came up the view as set forth by Monro, Sir Humphrey Davy, and others, analogous to the Cartesian, that a living principle pervades the universe, and governs all things. Some of this school suppose the universal principle to be subordinate to the Deity; but a greater number, like Carpenter, Prichard, and especially many of our present geologists, as Lyell, &c., regard it as the Deity Himself, whereby the latter, either directly or by implication, confound nature with God. The doctrine becomes, here, either atheistical or of a direct atheistical tendency; and we have, as a renewed consequence, the assumption of spontaneous generation.*

167, *c*. Those great luminaries, Hunter and Bichat, came forward in good time to rescue the philosophy of medicine from the degradation with which it was threatened by chemistry and physics, and have left an impregnable shield to all future ages.

167, *d*. Tiedemann, too, soon after appeared with his "Physiology of Man," in which the doctrines of life are ably expounded, and which must be ranked as one of the productions of an original mind. Tiedemann could not believe that there was any sincerity in the absolute rejection of a peculiar governing principle of living beings. "How ever different," he says, "may be the names chosen by physiologists and physicians to designate this power, however various the ideas they attach to it, yet all must agree on the essential point, that of regarding it as intended to maintain living bodies, vegetable and animal, and all their parts, during a certain space of time, in a state of integrity, in the composition, organization, and vital properties that are peculiar to them, and to render those bodies capable, at a certain period of their existence, of producing beings of the same species as themselves, which beings are confined to the same determinate mode of formation and development, and exhibit similar phenomena." "We are bound, therefore, to consider the principle which presides over those different acts, as a power inherent in all parts of living beings, and we cannot assume that, either in vegetables or animals, it is limited to any one part or parts. All the parts of a plant, the roots, stem, branches, leaves, flowers, wood, and bark, are nourished. Nutrition takes place in all the tissues and organs of animals. The con-

* See Medical and Physiological Commentaries, vol. i., p. 25, and vol. ii., p. 124–140 Also, "Examination of Reviews," p. 43; "Notice of Reviews," p. 4; "Essays on Vital ity," &c., p. 17.

tinual tendency of this power to preserve the individual and all its parts, forms the prominent character of individual life, and is presented to us *as the most important internal condition of life.* This power not only converts the alimentary matters, drawn from without, into nutritive fluids, endowed with special properties and assimilated by it, but it also introduces them into the solid organic form, determines and regulates the composition, the organization, and the vitality of parts. Every living body is exposed to external influences, which urge it to manifestations of activity. Every one, however, under certain external circumstances, retains its form, its composition, and activity. Certain external impressions, however, of a mechanical or chemical nature, and divers organic matters, vegetable and animal poisons, are able to ANNIHILATE *this power,** and thus to cause the death of the living bodies on which they operate."

167, *e.* Next came the illustrious Müller to aid in arresting the almost universal onslaugh, in Europe, that seemed to threaten the extinction of every sage in medicine from Hippocrates to the exit of Bichat. Under the magic wand of Andral, the venerable doctrine of humoralism reared its portentous form; while Louis substituted morbid anatomy for the science of pathology, and Liebig, and his school, with fire and acids, overrun the whole domain of medicine.

Although Müller employs the language of Stahl, in relation to a vital principle, I think it rather designed as a forcible mode of expression, than as imputative of intelligence. Thus, "*this* RATIONAL *creative force,*" he says, "*is exerted in every animal strictly in accordance with what the nature of each part requires.*" The fact is truly stated; but it reposes on great laws of organization, not upon intelligence. That such is Müller's view appears from another expression, that, "*the formative or organizing principle is a creative power, modifying matter blindly and unconsciously.*" The radical fault of this philosopher consists, like that of Van Helmont, Stahl, Hoffmann, and Paracelsus, in referring many vital results of organic beings equally to a "vital creative principle" and to chemical forces.—See MULLER'S *Physiology.*

167, *f.* So remarkably different, however, are all the results of life from those of dead matter, that some of the shrewdest physiologists, of our own day, can scarcely avoid the chimerical theory of Van Helmont. Thus, even Marshall Hall:

"The principle of action in the cerebral system," he says, "is the ψυχη, or the immortal soul. Upon the cerebrum the soul sits enthroned, receiving the embassadors, as it were, from without, along the sentient nerves; deliberating and willing, and *sending forth its emissaries and plenipotentiaries, which convey its sovereign mandates,* along the voluntary nerves, to muscles subdued to volition."†—(HALL

* See "Examination of Reviews," p. 26–28; also, this work, § 189 *b*, 350¾ *b*.

† I have somewhere seen it suggested that the doctrines of vitalism may be applied in support of *animal magnetism.* But, while vitalism is fundamentally opposed, even to speculative theory, and rests alone on the absolute phenomena of organic beings, it is not less true that, with rare exceptions, the medical advocates of animal magnetism are, as in ancient times, among the physical theorists of life (§ 844). Dr. Elliotson is of that denomination. (See *Med. and Phys. Comm.*, vol. ii., p. 137, 138.) And, although I have, in the foregoing work (vol. i., p. 632), expressed my opinion of the countenance which has been given to this imposture by distinguished members of the medical profession, I will add my entire concurrence in the following sentiments by Hannah Moore. In a letter to Horace Walpole, dated 1788, she remarks, "I give you leave to be as severe as you please on the *demoniacal mummery* which has been acting in this country; it was, as usual with

on the Nervous System.) Here I suppose the "emissaries and plenipotentiaries" to be nothing more than the nervous power, a property

prodigies, the operation of fraud upon folly. In vain do we boast of the enlightened eighteenth century, and conceitedly talk as if human reason had not a manacle left about her, but that philosophy had broken down all the strong-holds of prejudice, ignorance, and superstition; and yet, at this very time, Mesmer has got a hundred thousand pounds by *animal magnetism* in Paris. Mamaduc is getting as much in London. There is a fortune-teller in Westminster who is making little less. The divining rod is still considered as oracular in many places. Devils are cast out by seven ministers. Poor human reason, when wilt thou come to years of discretion!" (§ 844.)

I may also add the following extract from the *New York Journal of Medicine* for March, 1845:

"*New York, Feb.* 14, 1845.

"Mr. Editor,

"Dear Sir—In a letter of the 11th inst., addressed to myself, you desire me to state what I witnessed of the firmness of a young gentleman, upon whom the operation of exsection of the inferior maxillary bone was performed by Prof. Mott, 'and the reflections to which it gave rise, as bearing on the subject of alleged surgical operations without pain in the mesmeric state.'

"The case to which you refer is briefly reported in the January number of the New York Journal of Medicine, by some person, who, like myself, was present at the operation. The subject is there stated to have been 'a fine intelligent young man, whose *heroic deportment* greatly facilitated the operation.'

"Perhaps it is enough that I should have quoted the expressive language of one, who appears to have looked on with the same admiration as myself; though these examples of 'heroic deportment' are common enough in the walks of surgery, especially among females; and that, too, without mesmeric imposture. The same eminent surgeon, who operated in the case which is the subject of these remarks, will tell you that he has extirpated many breasts, rendered highly sensitive by carcinomatous disease, without observing any evidence of pain. But there was something in the case of Mr. Baker, which certainly better deserved the encomium of 'heroic,' than any thing I had ever before seen, or heard of, or even imagined as within the compass of human fortitude.

"This case, therefore, is interesting at this moment, as evincing a perfect capability of enduring the most intense, and sudden, and prolonged pain, without emotion, and as forming a test by which 'the subject of alleged surgical operations without pain in the mesmeric state,' will receive the explanation which you seek.

"The case is also physiologically interesting, and interprets the composure of those organic movements, under similar conditions, which has been set forth in behalf of animal magnetism.

"To appreciate properly the 'heroic deportment' of young Baker, you must imagine yourself to have been a spectator; follow the able surgeon in all the capital steps, and in all the minor details of the operation, and watch attentively the 'deportment' of the subject. He was laid at a convenient elevation upon a table, his feet crossed upon each other, and his hands lapped. I mention this position, because he did not move his feet, nor displace his hands during the operation.

"Now observe the operator; first, making a long and deep incision among the muscles of the neck, and then tearing his way down to the carotid artery, and throwing and tying the ligature. It was, in itself, one of the most capital operations in surgery; but, owing to the dexterity with which it was performed, and with an operation still before us far more difficult, and tedious, and dangerous, this grand step toward the exsection of the jaw lost much of its usual interest to the spectator. But it was not the less painful to the sufferer; who, however, sustained it without betraying the slightest evidence of pain.

"Next came the circular incision, reaching all the way from the joint of the maxillary bone, down along its lower edge, up to the middle of the chin. This was done by one rapid, immense sweep of the knife; but there remained the same imperturbable composure of the patient. Not a sigh, not a groan escaped, no muscle moved—the very eye did not wink. And then followed, as you may well suppose, a prolonged, tedious, painful dissection, in which it became necessary to exasperate the suffering by securing many bleeding vessels; till, finally, the operator was ready for his saw. But nothing had yet happened to elicit a single manifestation that the patient was not in a profound slumber, excepting that his eyes were open, and that he occasionally swallowed.

"But, before sawing the bone at the middle of the chin, it was necessary to remove one of the incisor teeth, and this was so firmly rooted that a straight forceps slipped in the hand of a capable assistant. Another pull, however, brought with it the tooth; but in neither attempt was there any more indication of suffering than in drawing a nail from a board.

"Then came the process of sawing, and this was calculated to greatly annoy the patient from a slight accident which happened to the saw, and which prolonged this part of the operation. Still, however, the same 'heroic deportment' distinguished the patient forbearance of the sufferer, the same unexampled complacency continued to mark every lineament of his face, his very eye displaying nothing but gentleness, softness, and calm resignation.

of the vital principle of animals, and whose *modus operandi* in developing voluntary motion I have endeavored to expound in sections 233, 243, 500 *d*.

167, *g*. For the proof of the existence of a vital principle, and of the government of organic beings by laws peculiar to themselves, as derived exclusively by myself from their composition, see that division of this work, and my Essays on the Philosophy of Vitality; and for the proof which I have offered as founded on the phenomena of life, see Essay on the Vital Powers, in Medical and Physiological Commentaries, vol. i., p. 1–119.

168. It is practically useless to investigate the nature of the vital principle. That nature, however, may be as well inferred through the medium of its phenomena, as the nature of the most tangible objects. The opinion of Müller commends itself to every right-thinking mind.

"Whether the vital principle," he says, "is to be regarded as *imponderable matter*, or as a *force or energy*, is just as uncertain as the same question is in reference to several important phenomena in physics. Physiology, in this case, is not behind the other natural sciences; for the *properties of the vital principle* are as well known in the functions of the nerves, as those of light, caloric, and electricity in physics." "But, without, in the remotest degree, wishing to compare the vital and mental principles with the imponderable agents, we must express our conviction that there is nothing in the facts of natural science which argues against the possibility of the existence of an *immaterial principle independent of matter, though its powers* be manifested in organic bodies—in matter."—MÜLLER's *Physiology*.

"The bone being separated at the chin, the dissection was resumed among the important parts, and though conducted with all possible skill and rapidity, it was necessarily tedious, as well as hopelessly painful, and, therefore, still calculated to try the firmness of the stoutest heart. A great extent of all kinds of tissues was divided, and, of course, no small proportion of nerves. Bleeding vessels continued to be secured, the difficult division of the articulating ligaments performed with as much facility as its difficulties would admit; and after the removal of the jaw, remaining portions of diseased muscle, &c., were cut away, and which tended not a little to embarrass that 'heroic deportment' which had marked every stage of this great and triumphant operation. From its beginning to its ending, which occupied one hour and a half after the first incision till the final extirpation of all the diseased mass, the sufferer did not manifest the slightest evidence of pain, or of impatience, or of fatigue, either by language, gesture, expression of countenance, winking, groaning, sighing, or any other imaginable method by which the mesmerite might be disposed to evade the overwhelming rebuke which the recital of this case cannot fail to inflict on his love of the marvelous, or his love of mischief, or his yet more culpable designs on human credulity.

"I have said that there was something physiologically interesting in the foregoing case beyond its simple merit of an 'heroic deportment,' and that it goes to the very depths of mesmeric assurance and duplicity. It was this:

"On feeling the pulse of the patient twice during the operation (the last time after the lapse of an hour), I found it calm, undisturbed, and with about the same frequency it had before the operation was begun. This proves to us what I have before expressed, that it is not pain, but the consequent mental emotions which affect the organs of circulation, whether the heart or blood-vessels.

"Thus ended an operation, unequaled in the annals of surgery; alike triumphant to the surgeon, to American Genius, to the admirable subject, to the cause of truth, of morality, and of sound religion.

"If you desire it, you may publish the foregoing statement, to which I should add some comments had I not already contributed my part, in a medical work, toward the suppression of one of the greatest nuisances that has yet infected the moral and reflecting part of the community. I have, however, some developments in reserve, which will probably see the light when the parties interested may be beyond the reach of greater reproof or mortification.

"I remain, very truly, your friend and obedient servant,

"MARTYN PAINE."

In the language of Liebig, "*In regard to the nature and essence of the vital force, we can hardly deceivé ourselves, when we reflect, that it behaves, in all its manifestations,* EXACTLY *like other natural forces; that it is devoid of consciousness, or of volition, and is subject to the action of a blister*" (§ 165, *a*).

169, *a*. We know, however, but little of the nature of the principle of life, and as little of the most obvious material substances; but, while this proposition is sufficiently plain, it is extensively argued that the vital principle, or organic force, has no existence, because it is not obvious to the senses. Thus neglecting its infinite phenomena (our only knowledge of the most sensible existences), the age has run into a materialism that takes in its way the soul itself.

Our great interest lies in the phenomena of nature. Through these phenomena their causes may be sought; their nature but very imperfectly. We can only describe matter by its manifestations; and so of the soul, and the principle of life. Of the nature of the soul, however, we have, as it respects its spirituality and some other important attributes, a special Revelation.

169, *b*. If organized beings possessed a principle of life that could, like light, *be seen*, they would then be allowed to be governed by this agent, and we should be relieved of the encumbrance of the physical and chemical hypotheses. But, though no such principle address itself to the sight like electricity or light, its existence is far more variously attested by other phenomena, and more so than all the other powers of nature; and these phonomena being wholly different from such as appear in the inorganic world, it is *prima facie* evident, that powers or properties which are predicated of them carry on the processes of health and disease; while the scrutiny of ages has never produced a fact in opposition.

169, *c*. Indeed, with so much light upon our subject, so much of fact to substantiate our conclusions, it would seem highly probable that all the facts which may be raised in opposition have no relative bearing, and that they are brought forward in the spirit of hypothesis.

169, *d*. The more comprehensive a law may be, the more readily is it known and determined, and the less likely is it that apparently conflicting facts will arise. Whenever such are produced, it is owing to a proper want of investigation. The facts are examined superficially; and the speculative or the credulous mind seizes upon some prominent characteristic, and pushes its opposition to nature under the spur of novelty, or the delight of discovery, or the goad of ambition.

Since, also, we seek, alone, for the existence and the nature of causes by means of their phenomena, he is no philosopher who refuses an inquiry into causes, from want of other means of information. The objection has never been raised in any science excepting medicine; but here we are told by many, that we have no means of reaching even the existence of the properties of life as contradistinguished from those of inorganic matter. It is this blindness, in part, which refuses to apply to the science of life the universal fact, that the phenomena are the only index to the forces which govern the inorganic world, that has embarrassed the progress of medicine, and encumbered it with a spurious philosophy.

169, *e*. Conscious, then, that I have taken my stand upon ground which true philosophy will recognize as her own, I shall go on with an investigation of the properties of life, as the source of all vital phenomena, of all morbid conditions, and which constitute life itself, and lie at the foundation of medicine. I shall enter far more extensively into an analysis of those properties than any other writer, shall set forth original views as to the character and office of the nervous power, and as to the mode in which this power participates in the operation of remedial and morbific agents, and endeavor to show, also, that, in proportion as philosophy may depart from the deductions which are founded on the phenomena of living beings, so must all such philosophy be fundamentally false, and become the unavoidable cause of practical errors of the highest moment.

169, *f*. Nor is it a small part of the proof that vitalism is founded in nature, that it is consistent throughout; seeking no multiplication of causes, but serving as an impregnable and universal foundation for every fact and every rational principle in physiology, pathology, and therapeutics; and, therefore, uniting all the principles relative to life, health, disease, and the art of medicine, into one consentaneous, harmonious whole. What a contrast with the mechanical and chemical speculations, or those commingled with vitalism! What a boundless source of stupendous philosophy for the votaries of one; what unmitigated confusion, and corruption of knowledge, and misapplication of mind, for the disciples of the other! How truly, and with what sublimity on the one hand, and imbecility on the other, is here exemplified the great distinction between man and his Creator, that the former devises in parts that may have no congruity, while the latter perfects the whole and *all together* (§ 63, &c., 74, 80, 117, 137, 143, 155, 156, 266, 323–326, 387, 399, 514 *h*, 524 *d*, 526 *d*, 638)!

170, *a*. The vital principle is a whole, in respect to its substantial nature, and is common to vegetables and animals. Organic matter, or an organized substratum, is necessary to its existence; and, since the perpetuity of organic matter depends upon the vital principle, it is manifest that both were brought into being without the agency of each other. The vital properties cannot be generated by matter, since upon them the existence of organization depends, nor is ther a single phenomenon that indicates their presence in inorganic substances; nor can they be produced by the forces of physics, since they are perfectly incapable of restoring the structure, or even its elementary composition, after the organized matter is decomposed; or, of reanimating the machine before decomposition has begun; while, on the other hand, these are the forces which lay waste the structure, and only so, after the signs of the vital properties shall have totally disappeared.

This unavoidable deduction goes far in confirming the Mosaic account of the different steps observed by the Almighty in the creation of living beings; that the sensible structure was first produced, and the spiritual and vital existences superadded.* The rudiments of that organization have been perpetuated in connection with the properties of life since they came from the hands of the Creator, and are the present source of all animated beings. Any doctrine adverse to

* See *Medical and Physiological Commentaries*, vol. i., p. 86–92.

this is not only atheistical, but is opposed to all the suggestions of reason* (§ 74½, 350¾ *k*). Nor is this all. The varieties in the different tissues of each animal, and of every plant, all the modifications of the vital properties in each species of animals and plants, in each tissue, and in every part, as already set forth (§ 133, &c.), and to be yet expounded, all the various functions that correspond to the modified structure and vital properties, all the secretions, even to the odor of flowers, &c., are exactly the same now as at the day they were called into being. This shows us that the properties and laws by which organic beings are governed, though infinitely varied, are as precise as the principle and laws of gravitation, as the conditions of the solar beam and the laws which they obey.

170, *b*. Again, the moment inorganic matter is brought into a state to receive the vital principle, however low in degree or energy, it must be exalted to an organic condition. If chyle, blood, semen, the gastric juice, &c., possess life, so, also, must they possess an organic state. This, indeed, is obvious from what we have seen of the manner in which their elements are united.

170, *c*. The living principle appears, therefore, to be neither the result of organic compounds, as supposed by Hunter and others, nor, as stated by Prout, Millengen, and others, the primary cause of organic conditions. Both have coexisted since they were the product of Creative Power, both are necessary to the vivification of dead matter, and the co-operation of both to the farther development of each.

171. The vital principle appears entire in parts when separated from their connections, if such parts be constituted with the requisite structure for independent nutrition (§ 304). Hence the development of the egg, the germination of seeds and flower-buds, the growth of shoots, and the multiplication of polypi from portions of the animal.

Müller, and others, suppose the vital principle to be divisible in such cases; but this construction regards the principle too much in the light of ordinary matter, and too little in that of a specific substance endowed with a variety of properties. These properties, so far as necessary to organic life, are implanted in every part, and each part may be regarded as a whole as it respects its own organic condition. In simple beings, therefore, where no great complexity of organs is necessary to the great final cause, nutrition, many parts of such beings may be capable of carrying on the process independently of the rest (§ 299, 302, 304, 322). It is probable, therefore, that the vital principle, in the foregoing cases, is no more "divided" than the soul or instinct as implanted in the ovum.—*Medical and Physiological Commentaries*, vol. i., p. 85, 87.

172. The principle of life, or life itself, may be summarily defined as a cause, consisting of certain specific properties, appertaining to organic matter, capable of being acted upon by external and internal physical agents, by the nervous power, and by moral causes, and of thus being brought into a state of action itself, and in no other way. Its action is exerted upon the organism, and upon certain external substances, as upon food. In the former case its action gives rise to motion, upon which all the functions depend; in the latter its operation

* See *Med. and Physio. Comm.*, vol. ii., p. 123–140. Also, "*Examination of Reviews*," p. 43; and "*Notice of Reviews*," p. 2, &c., in "*Med. and Physiolog. Comm.*," vol. iii.

is through the medium of the gastric juice in animals, but is more obscure in vegetables. The principle is creative so far as it combines the elements of matter in peculiar modes, and arranges the compound molecules into tissues and organs, and in modes identical with those which came originally from the Creative Energy of God, Who thus far imparted to the principle of life a formative endowment. The principle is capable of protecting the matter which it endows against the decomposing influences of all the physical agents by which it is naturally surrounded, while the extinction of the principle exposes the organic substance to an intestine chemical dissolution, and to the decomposing action of surrounding agents, which proceeds with a rapidity without parallel in the natural state of the inorganic world. The principle is also susceptible of certain limited changes from the influence of causes, moral and physical, which constitute the essence of disease; while other causes are capable of modifying the morbid changes in such wise that the principle of life takes on a restorative energy, through which it recovers its normal condition. The properties of the vital principle are variously and naturally modified in different parts, and undergo natural modifications at certain stages of life, giving rise to changes of organization, &c. (§ 62, 64, 133, &c.). These natural modifications will be farther explained in all the detail which is demanded by one of the most important topics in physiology; and I now proceed to the various specifications relative to the principle of life.

173. It is the special province of the vital principle in plants to combine the elements of matter into organic compounds; while in animals it can only appropriate compounds of an organic nature. This is a fundamental distinction between the two departments of the organic kingdom; from which it appears that plants are indispensable to the existence of animals.

174. The vital principle is subject to extinction, and this constitutes death. When speaking of the composition of organic beings, I adverted to the manner in which they resist the decomposing effects of chemical agents, and how the seed and egg are capable of being converted into complex living beings, or the whole animal and vegetable kingdom of being resolved into their ultimate elements, by the action of heat, air, and moisture. The same structure remains in either case, when life is suddenly destroyed, and the exact difference which arises in the two cases, from the influence of the same causes, can be owing only to the presence of peculiar powers in one case which have disappeared in the other. The cessation of the phenomena of life is the consequence of death; and, there is nothing to die (certainly not the forces of chemistry), but the principle of life upon which the phenomena depended, and which held the elements of structure in vital union (§ 584, 633).

175, *a.* As set forth in the *Medical and Physiological Commentaries*, "I believe the vital principle, vital power, organic force, organic power, are one substance, whether material or immaterial; and they refer, with me, to a universal cause of animal and vegetable life, or, rather, as constituting life itself. I believe, also, that this principle has various attributes, common or generic, and partial or specific; or perhaps I should call the former distinct properties. Thus, of the generic, we have irritability, mobility, sensibility, &c., and the modifications of

each of these in the same or different tissues form the specific or partial variations. These properties are also constantly varied in disease, and these variations I call *changes in kind.* The partial modifications in their natural state I designate as *variations in kind*" (§ 133–163, 171).

175, *b.* The vital principle has certain analogies with the mind or soul, and with the instinct of animals (§ 241). Each is inherent in organic matter, and the operations of each are through the medium of that matter. Each, respectively, is one substance, and each possesses certain distinct attributes or properties. Each is not only capable of acting by means of organized structure, but of being acted upon, and modified in its nature, and only so in conjunction with that structure (§ 189, 191, 234 *f*, 241, 566–568).

Even in the inorganic world we meet with a substance which is not without its light in the way of analogy. This substance is *light* itself. It is apparently one homogeneous, imponderable, substance, yet has a multitude of distinct component parts, each of which is endowed with specific attributes. These component parts, however, are distinct *entities*, which I do not recognize in relation to the properties of the vital principle, or of the soul. But the distinction is not important to my present purpose. The materialists necessarily regard the properties of life and of the soul as so many separate existences, whether imaginary or real (§ *d*, 188½ *d*, 222, &c., 234 *e*).

175, *bb.* It has been well said by Professor Draper, that

"Just in the same way that I am willing to admit the existence of forty different simple metals, so, upon similar evidence, I am free to admit the existence of fifty different imponderable agents, if need be. Is there any thing which should lead us to suppose that the imponderables are constituted by Nature on a plan that is elaborately simple, and the ponderables on one that is elaborately complex? That the former are all modifications of one primordial ether, and the latter intrinsically different bodies, more than a quarter of a hundred of which have been discovered during the present century?"

"We are thus forced to admit that rays of light, rays of heat, *tithonic* rays, phosphoric rays, and probably many other radiant forms, have an INDEPENDENT EXISTENCE, and that they can be separated, by proper processes, from each other."—DRAPER'S *Treatise on the Forces which produce the Organization of Plants*, p. 70, 71.

Organic life, however, needs only a single principle, or "imponderable," till it be shown that its supposed properties are individual existences (§ 165, *b*).

175, *c.* I have presented in the COMMENTARIES, in the Essays "*on the Vital Powers,*" and "*Spontaneous Generation,*" and my "*Notice of Reviews,*" certain facts which go to the conclusion that the mind or soul is a distinct immaterial substance, and that the instinctive principle of animals is equally a distinct substance from the brain. I will now add a few words, physiologically, in respect to the main argument of the materialists, drawn from analogy, that the mind, like the gastric juice, the urine, &c., is only a product of the functions of the brain.

The analogy is fictitious. Both the mind and instinct are entirely wanting in every known attribute of the product of other organs, and are *sui generis* in all their characteristics. This is sufficiently obvi-

ous. But there are other considerations which establish the distinction more fully, though they appear not to have engaged the attention of physiologists. What, for example, is the efficient cause of the production of bile, urine, &c.? Certainly the blood, in connection with organic structure and organic actions, and while these actions go on, bile, urine, &c., are uninterruptedly secreted; or, if arrested, it is from the failure of the organic processes. But, it is just otherwise in respect to the mind and the instinctive principle. These are completely suspended in all their manifestations during sleep, and often so with great instantaneousness. And yet there is every reason to believe that the organic functions of the brain continue to move on as perfectly as those of the liver, the kidneys, &c.; especially when it is considered that sleep may happen in almost the twinkling of an eye. Indeed, were any change to befall the brain, it should be more or less manifested by some consequent modification of all the organic actions; particularly as those of animal life undergo complete suspension.

Again, other peculiarities which contradistinguish the mind and instinct from every organic product are the quick transitions from sleeping to waking, and the occurrence of the change without any change in the organic functions of the brain. Take in connection the act of sleeping and the act of waking,—the instant suspension and the instant reproduction of the intellectual operations, and in all their isolated aspects, and the most obtuse understanding must concede not only the entire want of analogy with any other phenomena of nature, but that there must be a unique cause for such perfectly unique effects.

But, again, suppose some change in the organic condition of the brain as the cause of sleep; what is it, I say, that so instantly reinstates its functions when we pass from the sleeping to the waking state? What rouses the organ to its wonted secretion of mind? Are there any analogies supplied by the liver, the kidneys, &c. (§ 241)? What is it, I say, that brings the great nervous centre into operation in all the acts of volition, in all the acts of intellection? This question must be answered consistently, or in some conformity with the argument drawn from analogy. If that can be done, then it must be conceded that the analogy is irresistible, and the argument in favor of materialism incontrovertible. So, on the other hand, should the argument fail in this indispensable requisite, materialism must stand convicted of sophistry, insincerity, and a leaning to infidelity (§ 14, *c*).

The premises are perfectly simple. They are also sound so far as it respects all organic actions and results. The blood, as with all other organs, is the natural stimulus of the brain, and here as there all the organic phenomena are distinctly pronounced. They proceed, in all parts, with uniformity, and without interruption. Nothing can suspend them or modify them in the brain, or elsewhere, during their natural condition. So far the analogy is complete. Now, as it cannot be the blood, according to the analogy, which rouses the brain to action in *willing*, *reflecting*, &c., I ask the materialist the nature of the stimulus which operates upon the brain in eliciting the phenomena of mind? And again, I say, if he can sustain his answer by analogy, such is the consistency of Nature in organic philosophy, such the harmony of Design, that it would be in vain to oppose Revelation itself to what is so fundamental in Nature.

175, *d*. It is assumed by many late physiologists, as Drs. Carpen-

ter, Prichard, &c., after admitting and denying the existence of vital properties, and contending for their existence in the elements of matter, and the organizing agency of the forces of chemistry, that, nevertheless, all the results of organic beings are owing to the immediate acts of the Almighty (§ 64, *h*). This, therefore, as with the author of the "Vestiges of Creation," is only a circuitous method of confounding nature with God (§ 350¾ *h*–350¾ *l*). Let us, however, suppose that there is a Supreme Being in their opinion, who is the Author of nature, and that He is the Power who presides in organic beings, and regulates all their processes, and we shall see that the doctrine abounds with absurdities. Its advocates generally carry this ideal view so far as to affirm that the particles of matter are constantly maintained in union by Almighty Power, that chemical affinities are nothing but manifestations of that Power, that gravitation is only a constant emanation of the Deity, that digestion, circulation, secretion, excretion, &c., are only immediate acts of God. It is plain, therefore, that they can allow no other God than nature.

But, let us now look physiologically at this hypothesis. Organic beings are made up of matter, which, it will be conceded, is distinct from God, if we allow *his* existence as distinct from matter. It is therefore perfectly consistent to suppose that this matter is endowed with distinct forces for its own government (§ 14, *c*). If we regard, next, the results of vital stimuli, we have a palpable proof that they elicit actions and physical results through principles which possess the power of acting, or we must take up the absurdity of supposing that they act on God himself. The same may be affirmed of the poisons, medicinal agents, &c. But this will not hold either in religion or philosophy. Nevertheless, it is evident that some active agent is operated upon. If stimulants are applied to the nose, the heart may be thrown, on the instant, into increased action. Of course, it cannot be entertained that God is the agent acted upon in such a case, any more than when prussic acid destroys life with the same instantaneousness; and, therefore, He cannot be assumed as the cause of the healthy and natural functions (64 *h*, 241 *d*, 350¾ *g*–350¾ *o*, 376½, 733 *d*).

In my "*Notice of Reviews*" (in *Comm.*, vol. iii.) I have shown that the doctrine of "*the properties of life in the elements of matter*" is thoroughly material as it respects the soul (§ 14 *c*, 189 *b*, 350¾ *l*, *m*).

176. Besides an organized substratum and a principle of life, there is something still beyond not less important to all the great purposes of life. This consists of the actions and various results of life. If all animated beings existed in the state of the seed and ovum, the whole universe would be nearly without any other apparent animation than what is elicited by the forces of physics and chemistry. The movements of the heavenly bodies would be the principal demonstrative source of power.

Although, therefore, the actions and phenomena of organic beings, like the motions of the heavenly orbs, are merely the effects of a peculiar power which we call life, they are, nevertheless, the only attendants of life that interest our senses beyond the physical structure. Hence, it is not remarkable, considering how liable the senses are to take the lead of the understanding, that even the soundest minds have supposed that life consists of its results alone, and have overlooked the great efficient cause or power upon which the results

depend (§ 234 *g*, 247). Had they considered for a moment, however, the analogy which subsists between the motions of organic beings and those of the heavenly orbs, and that the latter depends upon a power which is called gravitation, and without which all the orbs would suffer the stillness of death, the conclusion would have been unavoidable that celestial motion is merely an effect, and, therefore, that all organic motions and their results depend upon moving powers. They should have seen, too, that when a drop of prussic acid, or of the spirituous extract of nux vomica, is applied to the tongue, all the phenomena of life are instantly extinguished, that nothing can reproduce them although the organized structure remains unimpaired, and that the whole being is immediately resolved into its ultimate elements.

177. The properties of life are the fundamental cause of all healthy and morbid phenomena. They are liable to be more or less diverted from their natural state by a variety of causes, and these new conditions constitute the most essential part of disease. This instability of the properties of life is at the foundation of all disease, and even of therapeutics (§ 642, *b*). Other causes, acting upon these morbid conditions, alter them in yet other ways, and contribute to their restoration to the natural standard. This is the aim of all our remedies; and the recuperative tendency of the properties of life (*the vis medicatrix naturæ*), when they are driven by morbific causes from their healthy state, enables them to recover spontaneously from the artificial conditions which are substituted by remedial agents for the more intensely morbid (§ 172, 893, &c.).

178. Notwithstanding the natural instability of the properties of life, they have a definite character in every part of the body, according to the nature of each part, at every hour of existence (§ 153–156).

179. The exact nature of disease depends mostly upon the foregoing definite conditions (§ 178), and upon the particular virtues of the morbific agents. The salutary changes produced by remedial agents involve the same principles. But, these definite changes, and the action of morbific and remedial agents, are liable to contingent influences from habits, &c.; as set forth under the fifth division of Physiology. Our calculation of results is thus embarrassed according to the nature and extent of the contingent influences (§ 756, *b*).

180. The vital properties are without renovation, or mutation in health, except as they are liable to certain natural modifications at different periods of life, or during gestation, or from the slow operation of external agents, as in the artificial temperaments. They must remain without renewal, to be forever ready for the work of nutrition, &c. (§ 237).

181. The permanency of the vital properties enables us to understand the nature of predisposition to disease, artificial temperaments, and hereditary diseases, which many refer to the ever-changing blood (§ 238, 666).

182, *a*. According as the vital properties may be modified, either in the foregoing manner (§ 181), or as in disease (§ 177), so will be the condition of the elementary combinations, and other physical products.

182, *b*. Nevertheless, the properties of life never undergo any radical change till they shall have passed the limit of their recuperative

power (§ 177), and are therefore approaching a state of extinction. Hence, essentially, in connection with the nature of the remote causes, the analogies among diseases (§ 670, 855).

183. In their highest development, the properties of the vital principle are six; namely, *irritability*, *mobility*, *vital affinity*, *vivification*, *sensibility*, and the *nervous power* (§ 175). They are called vital properties, vital powers, and vital forces; but are clearly attributes of a common principle, just as judgment, perception, the will, &c., are properties of the soul. They will be examined according to their nearest relations to each other in the most perfect beings, and their practical application.

184, *a*. The first four properties (§ 183) are common to plants and animals, and reside in all the tissues. They may be properly called *organic* properties, as they carry on the organic processes (§ 476–492, 516 *a*). The last two are peculiar to animals. This multiplication of vital properties in the animal kingdom harmonizes with the introduction of tissues and organs which have no existence in plants (§ 201, 222, 232, 450, &c., 500).

184, *b*. The nervous power has been considered a principle by itself, and often regarded by eminent physiologists as the galvanic fluid, generated by the brain, or other organs, and conducted by the nerves (*Med. and Phys. Comm.*, vol. i., p. 65–68, 107–119). Its phenomena, however, declare it to be entirely distinct in its nature from all things else; while its analogies to the other properties of life show it to be an element of the vital principle (§ 227–232). If it be difficult for the limited comprehension of man to surmise how this property should prove an agent to others with which it is associated, the difficulty is no greater than the admitted fact that the will may control other properties of the mind, and the passions. Nevertheless, it is unimportant in a practical sense, and in the institution of principles, whether the nervous power be considered an element of the vital principle, or a principle by itself (§ 175 *bb*, 186, 226).

185. Although the organic properties which are common to plants and animals are essentially the same, they possess greater modifications throughout than will have been seen to appertain to the same properties in the different parts of animals. But all the variations in the two organic kingdoms are intimately connected by close analogies; just as they are in the different animal tissues (§ 133, &c.). Much of the difference in the general vital constitution of the two kingdoms is owing to the presence in one, and the absence in the other, of the nervous system, and those corresponding properties which play so important a part in the animal tribes (§ 733, *f*). In both departments of organic nature, however, there is, essentially, the same principle of life, its great organic elements, and the same great functions over which they preside. Here, too, in the vegetable kingdom, in the modifications of structure and of the organic properties and functions, and of the laws which they obey, we witness the greatest simplification of life. The vegetable tribes, being also exempt from most of those secondary influences which so constantly embarrass our inquiries in more complex organization, especially from the complications that arise from nervous influence, are better subjects for the experimental researches which concern the philosophy of life; and the facts, therefore, which they supply may be carried up, for the

same general purpose, as sound analogies, to more complex beings (§ 191 *a*, 409, 733, 853).

186. The mental property, perception, is necessary to the exercise of specific and common sensibility, and the will to that of mobility as modified in the function of voluntary motion (§ 194, &c., 226, 241, 243, 500 *e*). Here we have not only other analogies between the intellectual and vital principles, but each is brought into direct action with the other (§ 175, 184 *b*).

187. The vital properties co-operate together in their functions, more or less, as they exist in any given being.

187½. The conditions now mentioned as to the principle of life, as well as all those to be hereafter stated, and the phenomena of which they are predicated, form other groups of facts, which, individually and collectively, contradistinguish the principle of life from all the forces of inorganic nature.

IRRITABILITY.

188, *a*. Irritability belongs to all tissues, and is the property upon which all vital agents, external and internal, physical and moral, natural, morbific, and remedial, produce impressions in organic life; except as sensibility is concerned in the function of sympathy (§ 201–203, 226). If motion follow, the impressions are transmitted to mobility, by which that property is roused into action, when motion ensues as a consequence. All actions or motions, in animal as well as organic life, are brought about by impressions on irritability (§ 205, 233, 257, 486, 500). This may be either by the direct action of the agent, or by the indirect action of the nervous power (§ 222, &c.).

When vital agents affect the organic functions in a direct manner, it is by direct action upon the irritability of the parts which perform the functions. This is true, in part, of the natural excitants of organs; as blood acts directly upon the irritability of the heart and blood-vessels, bile upon that of the intestines, food upon that of the stomach, &c. In these cases, however, influences are also transmitted through sympathetic sensibility to the nervous centres, and thence propagated to the muscular tissue of the organs (§ 201, 514 *f*). So, also, remedial agents operate upon the irritability of parts to which they are applied, and thus affect their functions in a direct manner. But their influences are commonly more extensive, and then they call into operation the nervous power by their action upon sensibility (§ 201), thus giving rise to the function of sympathy (§ 222, &c., 500).

When mental emotions affect the organic functions, it is by determining the nervous power upon the irritability of the parts (§ 226, 227). And, although sensibility receives the primary impressions in the function of sympathy, the resulting influences upon organic actions are brought about by a determination of the nervous power upon the irritability of the affected organs (§ 201, 226, 227).

188, *b*. When vital agents act upon specific sensibility, the results of their impressions are merely their propagation to the nervous centres, and a consequent action upon those parts (§ 194–204, 222–234).

188, *c*. I shall endeavor to show that the doctrine is entirely unfounded which supposes that vital agents produce their effects in organic life by direct impressions upon the nervous system, excepting so far as sympathy is concerned. This demonstration, indeed, was made in

the *Commentaries*, but mainly by other processes than will be presented in the Institutes. The fact alone, however, should be adequate, that plants have no nervous system, yet carry on all the essential organic processes that exist in animals; while they are alike liable to corresponding results from the operation of morbific and remedial agents.

188½, *a*. Every thing which is capable of affecting irritability, and sensibility, is a vital agent. These agents are either natural to the body, as blood, heat, bile, &c., or external, as food, air, heat, light, electricity, &c. Irritability is perpetually alive to the stimulus of blood in all parts of the sanguiferous system, as it is to that of the sap wherever it circulates (§ 136). This shows the exquisite susceptibility of the property.

188½, *b*. Many vital agents, those just mentioned, are indispensable to the maintenance of organic processes, either in animals or plants. Hence, from maintaining the organic powers in constant action, they are called *vital stimuli*. Those of a morbific or remedial nature are known by these epithets, though, in a philosophical sense, they are vital agents. They are distinguished by very different characteristics from the natural agents of life; even all those which are stimulant to the organic processes; for they not only excite the properties of life, but are capable, also, of affecting their intrinsic nature. But, there are others, whose effect, in certain degrees of intensity, is directly the reverse of the foregoing, as hydrocyanic acid, tobacco, &c.; and these, when thus operating, are vital depressants (§ 441 *d*, 650, 743).

188½, *c*. Some of the vital stimuli which are natural to the body, as blood, and bile, and also food, subserve other purposes than that alone of rousing the action of organs. They are also acted upon and appropriated to the uses of the system. This is more extensively true of animals than of plants. In the latter case there are certain external stimuli which are indispensable to vegetation, and whose only operation is that of excitants, but which are comparatively unimportant to animals. These agents are particularly light and heat, and perhaps electricity. The heat which is most important to animals is generated by the living organism.

188½, *d*. An important error has prevailed among chemists, from their necessary want of physiological knowledge, in regarding the imponderable agents as the *causes* of life, and not as mere *stimuli* to those *real causes* which are implanted in the organization itself, and by which, of course, all the actions and results are determined. This vitiation of philosophy has beset, especially, the functions of animals as it regards their assumed dependence on electricity, and the functions of plants in their obvious dependence upon light. The fallacy of the former hypothesis is shown extensively in the Medical and Physiological Commentaries (*Essay on the Vital Powers and its Appendix*). Of the latter I will now say, that in all the relations of light to plants, we have the most distinct analogies, with other vital stimuli to guide us to the same certain conclusion, that, like other stimuli, it does but rouse the properties of life to certain special modes of action, by which they decompose carbonic acid gas, carry on the work of appropriation, &c.

But, thanks to my colleague, Professor Draper, whose name in early life glows upon the sunbeam, organic science is supplied with

an adornment which vies in delicacy, yet sublimity, with the attributes of the nervous power (§ 222, &c., 234 *e*).

The professor has obligingly furnished me with the following statement of the progress, and nature, of the discoveries in relation to the solar beam. Thus:

"Until the time of Sir Isaac Newton, it was universally supposed that light was a simple elementary body, and therefore incapable of decomposition.

"The great optical discovery of Newton consisted in proving that the white light of the sun, or of day, is in reality made up of many colored varieties. He fixed the number at seven: red, orange, yellow, green, blue, indigo, violet. He indisputably established that that which we commonly call *light* is made up of, and therefore contains, the seven prismatic rays. They differ not only by impressing the organ of vision with different sensations, but also in intrinsic brilliancy or illuminating power. It is to be remarked that of these the yellow is the brightest.

"It was the opinion of Newton, and his followers, that when light falls upon bodies and disappears, it is converted into heat; or, in other words, that heat is extinguished light. Sir W. Herschel, the astronomer, proved the separate and distinct nature of these principles. The proof chiefly depends on the fact that the brightest ray is not the hottest, and that in the sunbeams there exist rays in abundance which are wholly invisible, but which can rapidly raise a thermometer. That which we cannot see we should scarcely call light. Moreover, a vessel of hot water in the darkest place is invisible; yet common observation shows it is emitting calorific emanations. The independence of light and heat may therefore be considered as established.

"Some of the alchemists discovered that certain of the white salts of silver (the chloride) turned black under the influence of the sunshine. Toward the close of the last century it was shown that the rays which produced this effect were invisible, and therefore could not be regarded as rays of light. At a later period I showed that they could not disturb a thermometer, or communicate to our organs the impression of warmth, and therefore must be distinct from heat. From the circumstance that they are always accompanied by light, I gave them the provisional name of *Tithonic* rays, from the fable of Tithonus and Aurora.

"The same species of modification which light exhibits (as colors) has been traced by Melloni for the rays of heat, and by me for the Tithonic rays. But, as both these classes of rays are invisible, their coloration must be necessarily so too, and is known to us only by indirect facts. We speak of it, therefore, as ideal or imaginary. There are seven colors for heat and the chemical rays, as there are seven for light.

"It is worth remarking how complex the constitution of light is now understood to be, when contrasted with the opinion held by the predecessors of Newton (§ 183, &c.).

"I have established, as respects some of these rays, that they discharge extraordinary functions. It is the *yellow* ray of light which has control of the evolution of plants. Under its influence their leaves effect the decomposition of carbonic acid gas in the atmosphere, setting free its oxygen and fixing its carbon. This wonderful phenom-

enon is unquestionably the first step in the production of organized matter, such as starch, woody fibre, &c., from inorganic gases. The carbon is first fixed under the form of chlorophyll in the leaf. Chlorophyll occurs under remarkable circumstances as the coloring matter of bile.

"Extended investigations have shown that each particular ray of these principles exerts specific powers. The compounds in which silver enters are affected by those of a violet color; chlorine is most acted on by the indigo; and carbon by the yellow. It is for this reason, as I have shown, that to the animal eye the yellow ray is brightest. If nature could have formed a retina of which silver was the basis, the indigo would have been the most brilliant ray. All our conceptions of beauty in colors depend, therefore, on the physical peculiarities of the carbon atom. And it is a beautiful and interesting fact, that the ray which evokes from atmospheric air the multitude of forms composing the vegetable world has charge of the process of vision in all animals.

"Dr. Gardner discovered that the movements of plants are chiefly directed by the indigo rays of light. They grow in the direction in which it falls upon them; and the blue color of the sky is one of the causes of the upright growth of stems.

"Besides the three classes of rays which I have mentioned, there is a fourth, of which much less is known; the phosphorogenic rays. These take their name from the fact that when they fall on certain bodies, such as the diamond, Canton's phosphorus, &c., they cause them to glow with a pale or splendid light. The extraordinary peculiarity they possess is, that glass is opaque to them.

"The advance of chemical optics has sufficiently proved that each of the constituent rays of the sunbeam, or of light derived from artificial sources, has capabilities of its own. Thus, each of the seven rays of light impresses our minds with special sensations. The yellow, moreover, controls the growth of plants, the indigo their movements. Of the Tithonic rays, the blue is the one concerned in Daguerreotype portrait taking, and the red can bleach paper blacked with oxide of silver. The same peculiarities will undoubtedly be discovered as respects the rays of heat."

Professor Draper's analysis of the sunbeam, by subjecting plants to the various elements of the solar spectrum, demonstrates, what was still conjectural, the individuality of its component parts, and establishes their rank as distinct physical and vital agents. Analogy justified this demonstration; and had the professor proceeded upon the basis of analogy, and applied the spectrum to the philosophy of life, it would have been one of the most splendid achievements of the human mind. But, like Philip and Müller, in respect to the nervous power, he lost the opportunity; but in losing it, he reared another beacon upon the quicksands of chemistry (§ 476, 493, 528).

The chemical properties of the solar spectrum having been announced by other philosophers, it only remained to infer that, like all other things, the integral parts of the spectrum which had manifested peculiar agencies in the physical world would probably, if each were specifically distinct, exhibit greater diversities in organic life (§ 52, 136, &c.). It is this which *settles* the individuality of the numerous rays. The results of sensation, the test of the thermometer, and even

of chemistry, with their united force, established only probabilities. Nature alone had supplied the unerring, the "indisputable" requisite, the Vital Principle. And, although discovery is probably only begun, the principles of individuality, and of organic relations, are as well determined by the properties of one ray as by those of a dozen. That others, than such as are known, belong to the class of vital agents, there can be little doubt. The physical capabilities of other rays supply a strong analogy for this conclusion. It only remains, therefore, for the experimenter to follow the path marked out by Draper; and if it do not conduct him to equal glory, he will increase that of the projector, and multiply facts for the great principles involved.

It will be now observed that every tangible substance yields an overwhelming analogy in corroboration of the doctrine which I advance as to the vital relations of the solar spectrum; while the coincidence in the specific influences of its component parts upon organic life with every other distinct agent, equally in its own turn, surrounds the spectrum with a vital philosophy.

Nor is this alone the importance to organic philosophy of the rich discovery. The individual parts of the spectrum not only affect sensibility and irritability in modes peculiar to each, but, in beautiful harmony with all tangible substances, each part, respectively, affects certain organs only, according to their special modifications of irritability or sensibility, and according to its own peculiar virtues (§ 133 *b*, 136, 137 *b*, 150 *a*, 188 *a*, 190, 194, 199, 203). Here, also, it will be seen, is another analogical proof of the vital nature of the influences of light upon organic beings (§ 74 *a*, 303 *e*).

Much, also, may be found in Professor Draper's own conclusions to show the vital nature of the agency of light. Take, for example, the statement that the "*indigo* ray controls the movements of plants," and that "the *blue* color of the sky is one of the causes of the upright growth of plants." Now what intelligible explanation can chemistry offer of those phenomena in their undoubted relation to light? The unavoidable answer supplies an indisputable analogy for the vital influences of the *yellow* ray, &c. As to the decomposition of carbonic acid gas, it is the only phenomenon in organic life, and I may add animal, which Liebig abstracted, unequivocally, from chemical agencies (§ 350, nos. 66, 68).

If we now carry the foregoing analogies along in comparing the effects of heat and electricity with those of light upon vegetable organization, we shall readily see that a common philosophy attends the operation of the whole, and that light, in its relation to vegetable life, is nothing but a vital stimulus, adapted to the peculiarly modified vital properties of the leaf, as blood is to the sanguiferous system, sap to the circulatory system of plants, bile to the intestine, semen to the ovum, pollen to the germen, &c. (§ 133, &c.). Consider, too, the analogy which is supplied, in the foregoing aspect, by the action of light upon the retina (§ 234, *e*), and how it contributes to the production of various hues of the skin, and how, on the other hand, the skin becomes blanched, like the plant, by the exclusion of light. And the analogy may be extended to the motions produced in the iris by the action of light upon the "carbon atom" of the retina (§ 514, *k*). Nay, more, the action of light, as I have shown, by its absence, at

least, reaches far beyond the peculiarly modified sensibility of the retina (§ 199); since, by its long privation, the entire organ of vision ceases to be developed (§ 74). Again, by what chemical philosophy shall we interpret not only the painful effect of light upon an inflamed eye, but its aggravation of the disease? And here, by-the-way, its simultaneous action upon the sensibility of animal life and the irritability of organic life concur together in the demonstration.

And now to continue the analogies with electricity and galvanism. Either will promote the growth of plants which no degree or modification of light can exert. So will they, also, promote nutrition in muscles that are wasted in paralysis; and if the pneumogastric nerve be divided, the transmission of galvanism through the inferior portion will rouse the stomach to the production of the true gastric juice and partially restore digestion. And here I may stop to say, that the coincidence in the effects of galvanism upon vegetable and animal organization is one of the many facts which establish the general identity of the properties of life in both departments of the animated kingdom, while it proves that galvanism and the nervous power are perfectly distinct, though each be a vital agent (§ 73 *b*, 74, 185, 226). Again, also, galvanism is a remedial agent, affecting morbid functions after the manner of other remedies, which, with its analogy to light in promoting the growth of plants, shows farther that the latter is, in the same sense, only a peculiar stimulus to organic functions (§ 74, 303).

What is said by Professor Draper in the foregoing abstract on the subject of the yellow ray in its connection with sensation deserves a critical inquiry, not only for the sake of the facts, but as contributing light upon organic philosophy. The chemical doctrine of vision is so clearly fallacious, that any specific relations which may be shown between particular rays of light and the sensibility of the retina, may advance our knowledge, analogically, of the connection of the rays with organic functions, through irritability. But I see not how it is shown that the yellow ray "has charge of the process of vision in all animals," since "each of the seven rays of light impresses our minds with special sensations."

Moreover, if the yellow ray give rise to sensation by its action on the carbon atom, or by any chemical influence, then, also, do each of the remaining six, and each one in modes peculiar to itself, and in all the cases upon distinct bases. Nay, more, when the retina feels the united rays, each of the seven must simultaneously exert their specific chemical actions. Besides, how are those invisible rays employed which operate chemically upon inorganic compounds?

In whatever aspect, therefore, we may regard the chemical doctrine of vision, it is every where shown to be untenable. But, from the close analogies between the relation of physical agents to sensibility in animal life and irritability in organic life, if their action in the former case be not chemical, but vital, so is it equally in the latter, and *vice versa*. It is either vital throughout, or chemical altogether.

But, organic philosophy, through its analogies, should be able to explain what chemistry cannot as to the resulting sensation when the united rays of the sunbeam fall upon the retina. One example will do it. Thus, every distinct agent of positive virtues produces distinct impressions in organic life. But, by uniting two or more together, either mechanically or chemically, a new agent is created, which op-

erates either in an individual sense, or if by several virtues, as an entire whole. So, in respect to vision, the united virtues of the numerous rays of the sunbeam acting upon the sensibility of the retina give rise to sensation attended by a white light (§ 136, 188, 193, 199, 650, 872 *a*).

The intelligent reader may now test the foregoing philosophy by what is perpetually observed within himself, and bring to its illustration the exact analogies which I have indicated as being supplied by the different passions of the mind; how anger stimulates the whole vascular system,—how fear depresses it,—how shame acts upon the capillaries of the face alone,—how joy acts upon the heart and kindles the eyes in its own peculiar way, or its antagonist, grief, seeks the lachrymal gland, or expectation of food the parotids,—how fear, again, rouses the kidneys, or bathes the skin with perspiration,—how love poises its aim at the genital organs (§ 227, 234 *g*, 509, 512, &c.). If, therefore, light do not affect organic actions, and influence organic results according to the foregoing moral causes, and according, also, to all vital agents, but, on the contrary, its operations upon plants, and therefore upon animals, be of a chemical nature, then, by the clearest analogy, all other agents of life, the mind and its passions, every act of intellection, every voluntary movement, belong equally to the same category (§ 175 *c*, 349 *e*).

189, *a*. Where physical views of life obtain, their advocates suppose that vital agents operate directly upon the structure. This is one of the first steps in materialism. Many of the chemical school imagine, as Liebig expresses it, that "every motion, every manifestation of force, is the result of a transformation of the structure, or of the substance of parts;" that "every thought, every mental affection, is the result of a change in the composition of the substance of the brain." And so of every pulsation of the heart (§ 350). Others, again, who belong to the school of vitalism, to accommodate their language to the physical conceptions of the day, speak of the action of vital agents "upon the structure through the medium of the vital properties." This difference among vitalists is only verbal; since, by admission, the structure can only be affected "through the medium of its vital properties," upon which, therefore, the impression must be made. Hence, distinguished vitalists, Professor Caldwell, for example, who defend the semi-physical mode of expression, often fall into the simple realities of their philosophy. Thus the professor, in his "*Outlines of a Course of Lectures*," observes that "irritability and sensibility can be acted on by stimulants alone." "Purgative medicines act chiefly on our irritability," &c. (p. 185, 187). And so it ever happens with inquirers after truth. They cannot adhere even to ambiguities of language; and others who see the truth, but build upon hypotheses, are often betrayed into fatal contradictions (§ 64, 236, 345–350, 350¾ *n*, 699 *c*, 740, 819 *b*).

189, *b*. But, what is more remarkable, the most absolute physical philosophers of life, they who deride the existence of the "vital properties," and speak of their "destruction" as an absurdity, not only fall into the language of the vitalists, but unavoidably contradict their whole system of materialism, whenever they approach the realities of life. This is true even of Dr. Carpenter, who, in his review of my *Commentaries*, attempted their overthrow by satirizing the supposed exist-

ence of "vital properties," and particularly the supposition that properties could be "*destroyed.*" Thus, then, Dr. Carpenter, at a subsequent time, and in a work of great professional popularity. The capitals and italics are mine:

"It is a fact of some importance, in relation to the disputed question of the connection of muscular *irritability* with the nervous system, that when, by the application of narcotic substances to the nerves, their VITAL PROPERTIES ARE DESTROYED, the *irritability* of the muscle may remain for some time longer; and the latter must, therefore, be independent of the former. Hence we should conclude that *contractility* [*mobility*, of these Institutes, § 205] must be a property really *inherent* in muscular tissue, which MAY BE CALLED INTO ACTION *by various stimuli* APPLIED TO ITSELF, and which may be *weakened* by various *depressing agents* APPLIED TO ITSELF; and that the nerves have the power of conveying *the stimuli* which CALL THE PROPERTY INTO ACTION, but have little or no other influence ON IT."—CARPENTER'S *Human Physiology*, *Section* 376.—See, also, this work, § 175 *d*, 167 *d*, 291, 350¾ *b*; and *Examination of Reviews*, p. 8–12, 26–43.

It is important to the great objects of medicine, that I should now say, that the foregoing is only an example of numerous palpable contradictions of the physical views which form the fundamental philosophy of life in the foregoing work, and, I may add, of most others which are devoted to the propagation of medical materialism. It will be seen that enough is admitted in the preceding quotation to substantiate every doctrine advanced in these Institutes. There are the vital properties, in all their individuality, called into action by stimuli, and "acting" of themselves even beyond the doctrine of vitalists, or, again, "weakened by various depressing agents," and liable to be "destroyed;" though I do not allow, as affirmed in the quotation, that "irritability remains" after it is "destroyed." Finally, we have admitted, "that *the nerves have the power of conveying the stimuli which call the property* [*contractility, or mobility*] *into action*;" and which is all that is necessary to the whole doctrine which I have propounded as to the nervous power (§ 222–233¾, 500, &c., 512, &c., 893–905).

189, *c*. The impressions which are made on the vital properties become the causation of the changes which may ensue in the actions, or structure, of the solids, where the impression is made. No vital agents elicit actions, or a single phenomenon of life, when applied to an inorganic compound, not even from an organic being just dead from instant destruction by hydrocyanic acid, or by a pin thrust into the medulla oblongata. On the contrary, indeed, all the agents which had before contributed to the maintenance of life, now carry out the work of destruction, and more speedily resolve the organic fabric into its ultimate elements, than any inorganic compound (445, *e*). It follows, therefore, that agents do not elicit the actions of life by operating upon the organized structure; but upon those properties which hydrocyanic acid, &c., may extinguish in an instant of time; nor do they operate upon the functions, since those are merely effects (§ 176). And is it not a greater paradox that hydrocyanic acid, or aconite, &c., should destroy life in a second of time by its action upon the mere structure than upon that living principle which imparts to the organic kingdom all its peculiar characteristics? Or, as the blood, or joy, or anger, rouses the heart, or as fear brings on perspiration, micturition,

&c., or as the want of air throws into action the respiratory muscles, or as odors, light, &c., produce their sensations?

By facts of the foregoing nature, and by all those considerations which have been made in relation to the differences in the vital constitution of the different tissues, and of different parts of one and the same continuous tissue (as of the alimentary and pulmonary mucous membrane, § 133, &c.), it becomes perfectly obvious that the properties of life are something *per se*, something besides organization itself, or organic functions, and upon which the agents of life exert their immediate impressions.

There can, therefore, be no appreciation of the laws of organic beings, of the modus operandi of natural, morbific, or remedial agents, of healthy or morbid processes, of voluntary or involuntary muscular motion, of the results of the operation of the nervous power and sensibility, or even of perception, without a critical reference to the properties of life as the efficient causes, and as receiving the impressions which may be created by external and internal agents (§ 872).

190, *a*. Irritability, and other vital properties, are naturally modified, in kind and degree, in the different tissues, in tissues of the same order, and in different parts of one and the same continuous tissue (§ 133, &c., 199, 203, 227–232, 441).

These natural modifications are shown in all parts by the peculiar action of the natural stimuli of life; as blood upon the heart and blood-vessels, food on the stomach, bile on the intestines, urine on the bladder, the will, through the nervous power, upon the voluntary muscles (§ 215, 227, 486), and by the differences that arise from their action on parts to which they are not peculiar. And so of the diversified effects of external agents on different parts.

190, *b*. There are remarkable modifications of irritability in the ova of oviparous and viviparous animals, and in seeds. Semen is the only natural stimulus of the former, in their absolute state of ova; while in the ova of viviparous animals, the actions, after being roused by the stimulus of semen, must go on to a full development of the organic being, and in undisturbed connection with the parent; but, in the oviparous, when the ovum has acquired a certain development, the actions cease spontaneously, the properties of life no longer obeying the vital stimuli as in the other case. These properties then become dormant (and in the seed, also), and nature, having fulfilled her final cause, the ovum is expelled from the body, and the seed cast off, that they may be subjected to new agents. Semen will not now act upon the egg, but heat and atmospheric air become necessary to restore the actions, and carry out the process originally instituted by the specific stimulus of semen.

There are certain oviparous animals that present other peculiarities, and other changing modifications, of irritability in respect to their ova. At certain seasons their ova undergo a partial development from the influence of season, and from the stimuli supplied by the female parent. These influences, however, finally cease to operate, and the ovum is expelled to undergo the action of semen in the external world. This action again modifies irritability, and adapts it to other vital stimuli.

Again, it may be affirmed of many oviparous animals, at least, that a partial development of the ovum takes place, though imperfectly,

through stimuli supplied by the female parent, and the ovum is ultimately expelled as when incipient development is brought about by the stimulus of semen. But these ova are insusceptible of renewed actions, either from the stimulus of semen, or other vital agents (§ 71–73).

191, *a*. The variations in kind and degree of irritability (§ 190) adapt each part to be acted upon by peculiar natural agents, while the same agents may have a pernicious effect on other parts, in the great plan of organic life (§ 133, &c.). The same principle governs the operation of morbific, and, more or less, of remedial agents, and is one of the main causes of disease, and of the determination of disease upon one part in preference to another (§ 149–151). The principle is, therefore, very comprehensive, and refers as well to the kind, energy, and degree of the operating causes or agents, as to the kind and degree of irritability (§ 150). And so, also, of sensibility (§ 194).

The principle is not only seen in all parts of the organic being, but every distinct species of animal and plant has, in a collective sense, its own special modification of irritability, through which its organic habits as to food, composition, nutrition, &c., are specifically regulated. It is this which renders what is poisonous to one animal or plant salubrious or inoffensive to another. And this lets us into a knowledge of the reason why certain atmospheric influences induce the "milk-sickness" in the *kine* of the Western States, and probably in no other animal. It reveals to us how it is that the stately *platanus occidentalis* and the common *pecah tree* have been dying off over extensive regions of country, and why the potato-crop is cut off, year after year, in vast regions of Europe and America, while every other tree and herb escape the epidemics (§ 150). These very facts demonstrate, also, the principle as to the natural modifications of the properties of life, and establish, alone, the fundamental identity of the vital properties in the two departments of the organic kingdom (§ 185).

191, *b*. Again, more remarkable modifications of irritability, or changes in kind, are artificially effected by morbific and remedial influences, external and internal, physical and moral; and these, far more than a mere increase and depression of this property, constitute an essential part of disease. These affections of irritability give rise to new series of influences, from every variety of agent, and often very different from such as are exerted under circumstances of health (§ 542). Hence it is that ordinary food, &c., becomes morbific in diseased conditions, remedial agents operative, either for good or for evil, when otherwise they might fail of any effect (§ 226), and, upon this mutability, and varying susceptibility of the property now under consideration, is greatly founded the art of medicine. It is, especially, these varying conditions of irritability which demand so much critical reference to the exact nature of remedial agents, their doses, &c. (§ 49½, 871, 878), and to the mutability of the property is particularly due the salubrious influences which are exerted (§ 901).

191, *c*. And here we have striking analogies in the manner in which the properties of the mind are modified in their character and again restored to their integrity when the organic properties of the brain become affected in the foregoing manner (§ 175).

191, *d*. Remote analogies probably exist even in the inorganic kingdom; though we have apparently nothing there in this respect

which transcends other affinities between the two great kingdoms of nature. We do not find that dead matter is endowed with properties as specifically distinct from the matter itself as the living being and the properties by which it is governed. And, so far as this analogy extends to dead matter, its properties do not appear to be liable to any mutations in kind, but only in degree; and here it would seem that the analogy should end, since we do not find that instability in the mineral world which, in the organic, grows out of the mutability of the properties of life.

What I have thus said of the analogies between the properties of living and dead matter is sustained by the late researches of chemists. Thus, on the allotropism of simple bodies, it is said by Prof. Draper, that, "to a certain extent, the views of M. Berzelius coincide with those which have offered themselves to me from the study of the properties of chlorine. They are not, however, altogether the same. M. Berzelius infers that elementary bodies *can assume, under varying circumstances, different qualities.* The idea which it is attempted to communicate in this memoir is simply this,—that a given substance, such as chlorine, can pass from a state of high activity, in which it possesses all its well-known properties, to a state of complete inactivity, in which even its most energetic affinities disappear. And that, *between these extremes there are innumerable intermediate points.* Between the two views there is, therefore, this essential difference: From the former, it does not appear *what the nature of the newly-assumed properties may be;* from the latter, they must obviously be *of the same character, and differ only in intensity or degree,* diminishing from stage to stage until complete inactivity results."—Draper, *on Allotropism of Chlorine as Connected with the Theory of Substitutions.* 1845.

192. Irritability stands as a sentinel at all the openings and pores of the body, and between the capillary and extreme vessels of the arterial system; admitting and excluding according to its natural modifications in different parts. Thus, all but chyme is excluded from the duodenum by the pyloric orifice of the stomach, and all but atmospheric air by the glottis. The globules of blood are vastly smaller than the visible capillaries which carry only white blood, from which they are excluded by the peculiar irritability of these vessels. When admitted, as in inflammation, it arises from a morbid alteration of irritability. And so when the lacteals absorb deleterious agents, or the pylorus allows the escape of undigested food. There is no analogy between a set of inert tubes and the living ducts. And yet are we presented with tubular instruments of glass, &c., to demonstrate the laws which govern the circulation of the blood and of sap, and sponges and lamp-wick to exemplify the process of absorption as carried on by the lymphatics and lacteals (§ 289, 291).

193. Bichat confounded irritability with sensibility, by calling the former organic sensibility, and the latter animal sensibility. He made, also, a greater mistake in supposing that irritability and sensibility are only different degrees of one property. This fact derives its importance from the high authority of the French philosopher, and the errors into which he has thus led a multitude of others.

The coincident functions between plants and animals, and organic actions being carried on in parts of animals after the greatest possible destruction of the nervous communications, evince the clearest distinc-

tion between irritability and sensibility, however close their analogies in respect to the operation of physical agents. When nux vomica rouses spasmodic actions in a paralyzed limb, it is by its action on irritability, for sensibility may be extinguished, and not reproduced (§ 500, *d*).

2. SENSIBILITY.

194. Sensibility, which is peculiar to the vital principle of animals, resides exclusively in the nervous system. That which gives rise to true sensation is mainly limited to the cerebro-spinal system (§ 184, 523).

195. Through sensibility we learn the existence and nature of external objects. These objects make their impressions upon this property as we have seen of other agents in respect to irritability (§ 188, &c.).

Another important function is also performed by sensibility, which consists in the transmission of impressions to the cerebro-spinal axis, as a part of the great function of sympathy.

All the modifications of sensibility are designed for the transmission of impressions from the circumference to the nervous centres (§ 437, 438).

196. The nerves are the organs of sensibility, and the brain and spinal cord the recipients of impressions transmitted by this property through the medium of the nerves. Perception is also necessary to the recognized modifications of sensation; and, therefore, the perfect exercise of the power, in its function of true sensation, requires a healthy state of the foregoing elements (§ 523, no. 3).

197. Sensibility is said to be of two kinds, *common* and *specific*. I shall distinguish it into a third kind, which may be called sympathetic sensibility.

198. Common sensibility is the source of pain, and resides in all the nerves. It is generally dormant in the organs of organic life, but may be greatly roused by disease. The best examples of this latent state occur in the ligaments and bones. Its development by disease is a clear illustration of the light which is reflected upon natural physiological conditions by their morbid changes (§ 137, *d*).

199. Specific sensibility is peculiar to the senses, where it manifests very striking peculiarities. Light, alone, will affect the specific sensibility of the retina, the intrinsic virtues, only, of various substances give rise to tasting and smelling, certain mechanical impressions to hearing, &c. This proves a difference, or modification, of specific sensibility in the several organs of sense, by which, as in the case of irritability (§ 190, 191), it is adapted, in various parts, to the action of special stimuli, according to the predetermined uses of each part.

199½. The impressions transmitted by common and specific sensibility are received by the brain alone, or its equivalent. The spinal cord is only a medium of communication. These, also, are the kinds of sensibility which require for their operation the exercise of perception (§ 451, 523, nos. 1, 2); and it is these upon which true sensation depends. Whenever brought into operation, the mind takes cognizance of the transmitted impressions.

200. The foregoing (§ 197–199) are coincident with what we have seen of differences in irritability (§ 133, &c., 190, 191), though more strongly pronounced, and are clear examples of what is meant by

natural modifications of the vital properties; and illustrate those modifications which constitute the essence of disease (§ 133, &c., 191).

The three principal kinds of sensibility, and the several modifications of the specific kind, as shown by the special causes which, respectively, give rise to seeing, tasting, smelling, &c., also illustrate the principle which governs the special relations of different agents, natural, morbific, and remedial, to irritability as modified in different parts; and this, also, reciprocally illustrates the characteristics of sensibility. A harmony of laws prevails universally (§ 133–138). Like irritability, sensibility is also liable to artificial modifications from the action of external and internal causes; and, as will be seen, the nervous power is susceptible of even more remarkable influences (§ 226–232, 725).

201, *a*. The last section leads me to consider the third kind of sensibility, or what I have denominated *sympathetic sensibility* (§ 197). Its office will explain the qualifying term *sympathetic*, which appears to be necessary to avoid the confusion which prevails in the application of the general term to the distinct offices of exciting acts of intellection and of influencing organic motions, and of producing involuntary motion in animal life. There was a radical objection to Bichat's designation of irritability as *organic sensibility* (§ 193); but in the present term there seems to be a peculiar advantage (§ 451, *d*).

"Impressions," says Müller, "conveyed by the sensitive nerves to the central organs are either reflected by them upon the origin of the motor nerves, without giving rise to true sensations, or are conducted to the sensorium, the seat of consciousness."

When light produces vision, or odors give rise to agreeable sensations, it is due to specific sensibility. The mind perceives, and the effect goes no farther; there is no extension of the impressions beyond the sensitive nerves. Again, the light or mechanical irritants are productive of pain, and the effect is limited in the same manner. But here there is no specific sensation. It is the same in all the organs of sense. This, therefore, is due to common sensibility. At another time, however, the light induces a paroxysm of sneezing, or the odor syncope or disease. Here is a perfectly new train of results, the principal of which are in parts distant from the direct seat of the impressions. The primary influences have been propagated upon various organs by the nervous centres through the system of motor nerves. These influences, therefore, have called into action another modification of sensibility, and that is the *sympathetic* (§ 450, &c., 464, 514 *k–m*, 902).

201, *b*. This variety of the common property, like specific sensibility, belongs to certain parts only of the nervous system, and is the medium through which impressions upon all parts are transmitted to the cerebro-spinal axis, in the function of sympathy. Perception, and true sensation, therefore, which is rarely an attendant phenomenon, are not necessary to the office of this modification of sensibility, nor is a continuity of the nerves with the brain. Reflected motion may be as readily excited through the spinal cord as through the brain; "and we are in possession," says Müller, "of no facts which prove that the spinal cord, when separated from the brain and medulla oblongata, can be the seat of true sensation. The reflected motions excited by the irritation of the surface in decapitated frogs are no proof of this."

201, *c*. Sympathetic sensibility appertains to what are denominated the sensitive nerves, and the sensitive fibres of compound nerves, which are also, in part, the instruments of common sensibility. But, a remarkable anatomical distinction, and which goes far to sustain the variety of sensibility which is here indicated, is found in the sensitive fibres of the sympathetic and pneumogastric nerves; which possess, in the most exalted degree, the power of transmitting organic impressions to the nervous centres, but which are nearly destitute of common sensibility. Indeed, it is through this system of sensitive fibres that the whole organic department maintains the specific relations of its several parts (§ 129, 523, nos. 1, 2, 3, 6).

201, *d*. The impressions transmitted through sympathetic sensibility may be received either by the brain, spinal cord, or certain parts of the ganglionic system (§ 520); and either connectedly or independently of each other. When thus received by the nervous centres, they give rise to a development and transmission of the nervous power through what are called the motor nerves, and terminate in those influences which complete the function of sympathy, by giving rise to sensible or insensible motions, or modifying such as had existed.

202, *a*. The manner in which sympathies are brought about through the medium, in part, of sensibility, and the failure of impressions upon common and specific sensibility to generate sympathy, or to excite the influence of the motor nerves, and the absence of sensation in the former case, and the admissible absence of the brain, as well as other peculiarities, prove, abundantly, the existence of this third kind of sensibility. Besides, also, the prominent demonstrations to the foregoing effect, which occur in disease, this modification of sensibility is in universal operation in healthy states of the body; as manifested in respiration, and in the concerted action with which the various organs carry on their respective functions. Through this modification, all parts transmit to the cerebro-spinal axis special influences that are relative to their existing conditions, and these influences are propagated through motor nerves, and maintain a harmony of movements (§ 129, 464, &c.).

The special function of this kind of sensibility, and its co-operation with the nervous power in the function of sympathy, will be farther considered along with that function, and the function of motion, and again under the laws of sympathy, and the modus operandi of remedial agents.

202, *b*. It may be now said, however, that when sympathetic sensibility gives rise to motion, whether in organic or animal life, or whether sensible or insensible, it is through impressions received and transmitted by this property to the cerebro-spinal axis (unless the ganglia of the sympathetic be also a medium of reflex action), and a consequent development of the nervous power, which power then operates, through motor nerves, upon the organic irritability of parts which are brought into motion.

203. Like specific sensibility (§ 199), and the organic property, irritability (§ 190–192), sympathetic sensibility is variously modified in different parts, by which it is adapted to the reception of impressions from agents of particular virtues, and for their transmission to the cerebro-spinal axis, and for the ultimate generation of true sympathy; while the same agents fail of these effects in other parts (§ 133. &c.)

204. Another manifest contradistinction between sympathetic, and common and specific sensibility, is seen in the general failure of impressions made on sympathetic sensibility to act upon the mind, and therefore in the ordinary absence of all sensation. If sensation be an attendant phenomenon, it then arises from impressions simultaneously made upon common sensibility (§ 445, 464–467, 473, no. 5, 474, no. 4, 542).

3. MOBILITY.

205, *a*. *Mobility* is the property by which all motions are carried on in animals and plants. It is peculiar to the solids, though some late physiologists have ascribed it to the globules of blood, while others have mistaken the globules for entozoa (§ 233, 253, &c.).

205, *b*. Sensible and insensible contractility, as employed by Bichat, and muscular power, are bad substitutes for the name mobility. They lead to erroneous conclusions; since the heart, blood-vessels, and other muscular organs dilate or elongate, as well as contract, through the same vital property; and motion occurs in various tissues.—(*Med. and Physiolog. Comm.*, vol. i., p. 150, 379–391.)

The terms sensible and insensible contractility limit the law of motion to simple contraction, while there must be always a corresponding active dilatation, or the part would always remain in a state of tonic spasm. Elasticity will never explain the dilatation of the heart, of the veins, &c.—(*Med. and Physiolog. Comm.*, vol. ii., p. 147–156, 175, 176, 399–402).

206. The philosophical Macbride remarks that, "as irritability necessarily implies mobility of the animal fibres, this does not require to be considered a distinct property." If, then, the existence of mobility be thus implied, it is a distinct property; and when the phenomena of irritability and mobility are duly considered, it will be seen that they should be regarded in a separate sense. Irritability is certainly necessary to the exercise of mobility; but the former may be greatly exalted without a corresponding increase of motion. The distinctions are numerous and of great practical importance (§ 500, *d*).

207. The existence of mobility in plants is abundantly shown by the motion of their fluids, which no mechanical principle can interpret, by their secretions, and by other results analogous to those which depend, in part, on this property in animals. It is also manifested by the sensible movements of the leaves, blossoms, stamina, &c.; and from these we may reason analogically, and infer insensible motions of the sap-vessels, the secretory apparatus, &c., as is also done in animals.

Mobility, therefore, gives rise to sensible and insensible motions. They are generally sensible in animal life, and of either kind in organic (§ 476–492, 516, no. 2; also, *Medical and Physiological Commentaries*, vol. ii., p. 150, 379–391).

208. Mobility is brought into operation through impressions made on irritability, whether by vital stimuli in organic life, or by the nervous power in either organic or animal life (§ 188). The philosophy of this will be considered along with the attributes of the nervous power, the function of sympathy, and the laws of sympathy.

209. If sensation apparently give rise to motion, it may be occasioned by the action of external or internal causes upon sensibility;

but this impression is imparted to irritability and then to mobility, before motion can follow (§ 195); or, from the intimate associations and analogies between irritability and sensibility, the two properties may be simultaneously affected by the same agents. Where, however, sensation is accompanied by motion as an apparent effect of impressions upon common sensibility, it probably arises in all cases from a simultaneous impression upon sympathetic sensibility (§ 198, 201, 202).

210. Irritability may be increased through an exalted state of sympathetic sensibility, and organic motions may be thus increased through sensibility; which is nearly the same as the foregoing law (§ 209).

211. It is doubtful whether parts may be irritated without exciting mobility (§ 202); but it is otherwise with common and specific sensibility, as in seeing, tasting, &c., and in pain.

212. Mobility, like irritability and sensibility, may be in a passive or dormant state, as in the ovum and seed, or as sensibility exists in the organic life of animals. All are roused by appropriate agents, and could not be roused were they not already present. Certain animals, such as the wheel, and the sloth animalcula, may have all apparent traces of life extinguished, may be completely exsiccated, and be speedily revived by heat and moisture.*

The first impression of semen, or of heat, &c., upon the ovum, or seed, is made on irritability, through which, as the next step in the process, mobility is roused into action. Then follows the new elementary combinations.

We thus learn, in part, that life is a cause, not an effect.—(*Med. and Physiolog. Comm.*, vol. i., p. 9, *et seq.*)

213. Sensible mobility is especially manifested in the compound organs, taken as a whole (§ 205). Insensible mobility occurs in the small vessels (§ 207). But, the palpable evidences of a special law of motion in the small vessels are apt to be sacrificed to the negative fact that the motion itself is not of a visible nature. As well might we deny the existence of microscopical animals.

214. The insensible motions in organic life are the most important that occur, especially such as take place in the extreme capillary vessels; since these are the instruments of all the most essential actions and phenomena of life, and of disease.

215. Voluntary motion is brought into exercise by the will and nervous power, as will be set forth under my consideration of the latter property and the function of motion (§ 222–233¾, 500 *d*). The essential difference, therefore, between the motions in animal and organic life, lies in the nature of the stimuli; voluntary motion requiring the exercise of the will, while the organs of organic life do not obey the stimulus of the nervous power when excited by the will (§ 486). It is probable, also, that mobility has a peculiar modification in the muscular tissue of animal life.

Notwithstanding mobility, in animal life, is always subject to the nervous power, motion is here, as in organic life, independent of the nervous system (§ 443, 486).

* See SPALLANZANI'S Experiments in *Opuscoli di Fisca Animale, Opere,* t. vi., p. 482–556.

4. VITAL AFFINITY.

216. It has been seen that the elements of organic compounds are very differently combined from those of inorganic (§ 32, &c.). Hence has arisen the term *vital affinity*, as denoting a property peculiar to plants and animals, by which all their elements are united and maintained in combination. When death takes place, chemical affinities operate, and resolve the organic into inorganic compounds, or into their simple elements (§ 174).

217. Vital affinity exists in modified states in the two departments of organic nature; since, in plants, it unites the simple elements into organic compounds, while in animals, it can only operate upon compounds of this complexity. Vegetable organization is, therefore, more of a creative nature than animal (§ 13).

5. VIVIFICATION.

218. By *vivification*, in conjunction with vital affinity, life is bestowed upon dead matter. The elements of matter are, essentially, combined into organic compounds by vital affinity; but there is a progressive vitalization of the organic compounds till they become united with the solids. This shows that vital affinity must have an associate power of vivification.

219. Vivification belongs, particularly, to the assimilating organs, though its energy must be great in the gastric juice. It has natural modifications in all parts, and presents distinctions between plants and animals.

220, *a*. Vital affinity and vivification, like the other properties of life, are susceptible of morbid changes. This gives rise to changes in the general vital character, and in the composition, of the solids and fluids.

These changes in composition are inferred upon principle, as well as from observation (§ 665, *b*). No chemical analysis can detect them, unless it be an alkalescence or an acidity of the secreted fluids, or changes in the urine; and even these imperfect results are often surrounded by objections (§ 5½ *b*, 53).

220, *b*. Changes in some of the secretions, or in the milk, may be brought about by temporary influences, and independently of disease, as by emotions of the mind, the action of cathartics, &c. These also affect the condition of organs and their products in the various states of disease; and upon this depends the art of medicine (§ 852, &c.).

220, *c*, The alterations which take place in the solids and fluids are always the same in any given condition of the affected properties of life. They are, therefore, constantly liable to variations during the progress of disease, and are various in different diseases, and according, also, to the nature of remedial influences, and of those other causes by which they are affected independently of disease (§ 672).

221. The changes which arise in the solids and fluids from morbid conditions never approximate the condition of dead matter (§ 674). There is no "putrescency," though otherwise averred in the late reproduction of the humoral pathology. Living matter cannot generate dead organic compounds; nor can remedial agents reconvert the putrid into living solids and fluids (§ 17, 847, 901).

6. THE NERVOUS POWER.

222, *a*. The analysis which I shall make of sympathy establishes so clearly its functional character, that I shall remove it from among the properties peculiar to animals, where it has been hitherto placed. In the room of this function, generally regarded as a property, I shall substitute the nervous power, upon which, in connection with sensibility, the former depends (§ 201).

222, *b*. The philosophy of the operation of the nervous power in producing motion, under all its various aspects, as manifested in its natural regulation of organic actions (§ 202), in the phenomena of sympathy induced by morbific and remedial agents, or by the influences of disease, in the motions which are generated in the organs of organic life by the passions and analogous affections of the mind, in the movements of the voluntary muscles, in the production of sudden death from all causes, as well as the solution of other relative problems, and the physiological interpretation of the recognized laws of sympathy and their general introduction into pathology and therapeutics, were originally attempted by myself in the Medical and Physiological Commentaries, and subsequently, and more extensively, in my Essay on the Modus Operandi of Remedial Agents. Should the exposition there and now set forth prove to be well founded, it must necessarily result, sooner or later, in the overthrow of all the mechanical and chemical hypotheses in physiology, consign to its well-merited oblivion the humoral pathology, and place upon its true foundation the operation of remedial agents.

223. The nervous power appertains to the vital principle, resides exclusively in the nervous systems, and is, therefore, peculiar to animals (§ 184, *b*). It gives rise, however, to results in organic as well as animal life. These results, also, are far more numerous and important in the organic than the animal mechanism, while sensibility is especially designed for the latter. Unlike sensibility, also, in its function of sensation, perception is not necessary to the operations of the nervous power, nor does the latter, like sensibility in its office of producing sensation, require a continuity of the nerves with the brain for the function of sympathy, especially in organic life (§ 209).

The nervous power is constantly, though, for the most part, in insensible operation throughout the organic mechanism, and is the power which maintains all parts in harmonious action. For this special reason I have endeavored to show that the nervous power is superadded to the vital principle of animals, and that the complexity of organs and functions which it is designed to subserve, and the absence of its phenomena in plants, afford a substantial proof that the property belongs to animals alone.

224. The nervous power is exerted, especially, through what are denominated the motor nerves and the motor fibres of compound nerves, or "nerves of motion;" these nerves, however, being mainly dependent for the nervous power upon the brain and spinal cord (§ 201).

Nevertheless, there is reason to suppose that the nervous power is implanted in the motor nerves, as well as in the brain and spinal cord. The phenomena of contiguous sympathy, as when inflammation of the liver, the lungs, &c., is relieved by blisters, over the region of the

affected organs, can hardly be traced through the mechanism of the cerebro-spinal system, though they may, perhaps, through the ganglionic nerve. Again, also, the very division of a nerve will produce inflammation of the part to which it is distributed. In this case a shock of the nervous power must be determined by the nerve itself (§ 226). The experiment is precisely analogous to those in which Wilson Philip influenced the functions of various parts by irritants, &c., applied to the brain and to the spinal cord (§ 474 *b*, 480, &c.).

It is evident, however, that the nervous power is much less strongly pronounced in the nerves than in the brain and spinal cord; just as sensibility is less in the brain and spinal cord than in the nerves of sensation, and less in the trunk of a nerve than in its ramifications; or, as irritability and sensibility exist in very various degrees in numerous parts.

225. Like irritability, sensibility, and the other properties of life, the nervous power is capable of being acted upon by external and internal causes, both moral and physical, of being increased, or diminished, or altered in kind, according to the nature of the causes (§ 200, 203, 258).

226. The nervous power possesses the remarkable characteristic of being a vital agent to the property irritability (§ 184, *b*). It is also liable to artificial modifications from the operation of physical and moral causes upon the nervous system; and its influences upon irritability will correspond with the nature of its modifications; being thus rendered a vital stimulus, or a vital depressant, or a vital alterative (§ 150). When, therefore, this power operates in any unusual manner, organic and animal motions, whether sensible or insensible, will be variously modified, or produced, by calling mobility into exercise, according to the nature of the influences exerted upon the power (§ 188, 205, 216, 492, no. 5). These facts are known by the endless variety of phenomena which are relative to the nervous power (§ 165, 188½ *d*, 480, Exp. 12, 13, and 14).

227. The nervous power is brought into unusual operation very variously, according to the seat of the exciting cause (§ 951).

1st. Its operation is excited in a direct manner by irritants, &c., applied to the brain, to the spinal cord, and to the motor nerves. It is also excited directly by cerebral or spinal disease, by the passions, mental emotions, imagination, intense reflection, and by the will (§ 226, 486, 500 *d*, 940–951, 969 *a*, 974–977). In all the cases, the nervous power will be rendered stimulant, or depressant, or alterative to the organic properties and functions; and variously energetic according to the nature of the operating cause, and the intensity and suddenness with which it may operate (§ 480 *d*, 743, 951). In blushing, the power is rendered stimulant; by fear, depressant; by grief, anger, hope, &c., alterative (§ 844). These effects are also commonly very sudden, especially the physiological. Even such as are morbific are often almost instantaneous; and this rapidity of change ceases to be remarkable when we regard their near coincidence with the natural results, and that the same principle is involved in voluntary motion.

A close analogy subsists between all the foregoing direct causes and all the physical agents of life, whether natural, morbific, or remedial, as the latter may develop the nervous power sympathetically (§ 500). These analogies will have been variously illustrated. They

evince the simplicity of fundamental principles and the relationship and perfect harmony which prevail among the whole, even those which are especially relative to mind and instinct as superadded to the simple condition of the vegetable kingdom (§ 323–325).

2d. The operation of the nervous power is excited through the medium of sympathetic sensibility (§ 201–203). This complex process results in the true function of sympathy. Impressions are made by physical and moral causes, by disease, &c., upon the foregoing variety of sensibility, and according, also, to its different modifications in different parts, and the nature of the operating causes. The impressions are then communicated to the cerebro-spinal axis, or to other central parts of the nervous system, and there bring into operation, and variously modify, the nervous power (§ 224). The power, thus developed, thus influenced, or so modified in kind that it partakes of the nature of the transmitted impressions, which are more or less coincident with the virtues of the remote causes, is then exerted, through the motor system of nerves, upon the organic properties of distant parts, or of the nervous system itself (§ 208, 209, 462–469), by which those properties, and their resulting functions and products, are variously affected according to the foregoing circumstances. From this fact it also results, that the modified conditions which are brought about by the nervous power, when the preternatural operation of this power depends upon external causes, whether morbific or remedial, are more or less analogous to those changes in the organic conditions which are wrought in parts by the direct operation of the same causes (§ 188, 657 *b*).

228, *a*. It thence follows, that there is imparted to the nervous power, by the foregoing means (§ 227), more or less of the characteristic virtues of the remote causes, but *under the influence of its own nature*, by which the nervous power is substituted for those causes, and thus reaches, with its acquired attributes, and their various effects, every part of the organization, and, often, with great instantaneousness. It appears, therefore, that this constitution of the nervous power is wonderfully suited to the various exigencies of life; while, as will be seen in section 232, it grows out of its physiological nature as a regulator of organic actions.

228, *b*. It is also an important law that the nervous power is variously influenced in its morbific and remedial action by slight variations in the intensity of the operating causes, whether moral or physical; though a determination is simultaneously given to its action by the numerous other conditions already mentioned, and which may happen to be present. Thus, an impression from cold, as a blast of air, or a drop of cold water, upon the skin in syncope, will rouse the respiratory organs. Another impression from the same, and under other circumstances, will excite catarrh, or pneumonia, or articular rheumatism. One degree of impression upon the stomach by tartarized antimony will determine the nervous power upon the respiratory muscles (as will cantharides upon the bladder, or mercury upon the salivary glands), and vomiting is the consequence; while it simultaneously reflects the same power upon the skin, and other organs, and of which perspiration, &c., is a consequence. In smaller doses, the respiratory movements are not affected, but only the condition of the skin, &c., and in lesser degrees. But, these examples embrace

only certain parts of the influences in each case; while in others they are far more complex, one sympathetic result becoming the cause of others, till, through a single impression upon the skin, various circles of morbific or remedial sympathies may be instituted (§ 743).

229. When disease operates in the foregoing manner in exciting the nervous power, and determining it with alterative effects upon remote parts, or upon the nervous system itself, it often imparts to it a modification by which a similar condition of disease is generated in the parts upon which the power is thus determined. Hence the consecutive inflammations which are often springing up, sympathetically, in various parts. But, this depends, more or less, upon the nature of the organs secondarily affected, upon their precise condition as diverted more or less from their healthy states by other causes, upon temperament, age, sex, &c. When, therefore, the nervous power is developed by disease, other conditions varying more or less from the primary affection are observed among the common effects. For the same reasons, also, when morbific and remedial agents operate through the medium of the nervous power, the results may be very various.

230. If the nervous power be brought into preternatural operation in a direct manner (§ 227), as when impressions are made upon the brain, or spinal cord, or the trunks of nerves, or by cerebral disease, or when the mind or passions develop its operation, it is also liable to modifications, and corresponding effects, as when the impressions are communicated through the medium of sympathetic sensibility. Thus alcohol, applied to the brain or spinal cord, increases the action of the heart and capillary blood-vessels, and so do anger, joy, hope, love, imagination. But, a watery infusion of opium or of tobacco, applied in like manner, depresses those actions, and so do fear, grief, and anxiety. We see, also, various other organic functions affected in a corresponding manner (§ 480–485, 489–492, 943, 945). In these cases, the nervous power is often determined, with more or less effect, directly upon the organic properties of the brain, and may extinguish them instantly. A sudden explosion of anger may, in this manner, induce apoplexy, while in other cases the destructive influence of the nervous power is expended mainly upon the heart. Inflammation of the brain determines the nervous power directly upon the cerebral vessels which carry on the morbid process, and thus increases its force and obstinacy. So with many morbific and remedial agents of a physical nature, which, when applied to the stomach, excite the nervous power indirectly, or through the medium of the sensitive fibres of the pneumogastric and sympathetic nerves, but in which cases the nervous power is determined upon the organic properties of the brain, or of the spinal cord, or of the individual nerves, as well as upon those of other parts. Such is the case with all the narcotics, strychnine and analogous substances, prussic acid, aconite, &c., which bear specific relations to the nervous system; either exciting or removing morbid states of the brain or nerves (§ 487 *g*, 526 *d*).

231. It is not alone the general functions of tissues and of compound organs which are affected by the nervous power in the foregoing manner (§ 227–230), but equally, also, those of the intimate organization of all parts, upon which nutrition, vital decomposition, &c., depend.

232. The modifications of the nervous power now described (§

227–230) are analogous to those which we have seen to be exerted upon irritability and sensibility (§ 191, 200), and they spring from that physiological constitution of the nervous power which is designed for great natural purposes in the animal economy. This power is manifestly associated with the vital principle of animals (§ 184, *b*) as a regulator of their multifarious parts, by which the whole are maintained in harmonious action, or by which the varying changes and failures of some shall institute vital changes in other parts that shall contribute to the restoration of the former, or exempt the general organism from the evils which would otherwise arise (§ 184). Voluntary motion (§ 215, 486), respiration, a permanent contraction of the sphincters, are also other final causes of the institution of the nervous power. The power is in perpetual operation in every part of the animal organization, though more obviously pronounced in some of its results than in others, as in the function of respiration, the permanent contraction of the sphincters, the motions of the iris, &c. It is, however, not less constantly operative, though with less intensity, in all organic processes, whether the general functions of a compound organ, or those of its individual economy, and forever stretches its universal sway, as a harmonizing power, over the whole organic mechanism. This power, therefore, is rendered exquisitely susceptible to the most astonishing variety of physical, vital, and moral causes; and, that it may feel and transmit the influences of the vital changes that may befall one part or another to other parts, for the maintenance of the great balance of functions, and to fulfill the office of restoration as well as of conservation, there is imparted to it, as to the other properties of life, a partial mutability in its nature, conformable to the various impressions exerted upon it, and by which it is rendered variously and usefully alterative to morbid conditions; and since, also, such alterative effects as are demanded by morbid states could not be exerted by a natural vital agent in its unmodified condition. Thus we have, in the obvious constitution of the nervous power, as manifest in its common functions, a principle of interpretation for all the variety of changes that are not less obviously exerted upon it by morbific and remedial agents.

233. The nervous power does not generate motion either in animal or organic life (§ 476–492, 516, nos. 2, 7). It only influences the organic property mobility, upon which all motion depends, through the medium of irritability (§ 188, 205, 208, 209, 226). Even voluntary motion is entirely independent of the nervous system, excepting as the nervous power is a stimulus to irritability. In the production of this complex function several elements are concerned: 1st. The will, operating as a stimulus upon the brain, develops the nervous power; 2d. This power is then transmitted to the voluntary muscles, where it acts as a stimulus upon irritability (§ 226); 3d. Mobility is thus called into exercise, the immediate result of which is voluntary motion (§ 205, 206, 208, 209, 245, 256, 476 *c*, 486, 487, 492, no. 7, 500 *d*). However complex, and destitute of analogies in the world of mere physics, this phenomenon may be, I have no doubt that the solution which I have offered will be received by every philosophical mind which may attentively consider the nervous power in its connections with the motor nerves, and the experiments of Wilson Philip (§ 464, &c., 476, &c.).

Since, also, the nervous power has no existence in plants, their actions are alone influenced by the physical agents of life; and, having no sympathetic relation of parts, the diseases of one part are felt by other parts only through the common laws of nutrition, while, also, remedial agents are curative by their local action alone.

233½. The nervous power, in a manner analogous to its determination upon the sphincter of the bladder after the evacuation of the urine, may be propagated upon distant parts, with morbific or curative effects, long after the removal of the agent by which it was originally excited. This is owing to the continued change, or impression, wrought upon the part to which the agent was applied (§ 514 *g*, 516, no. 6).

233¾. One of the most remarkable laws of the nervous power is that of its determination through particular nerves upon certain parts, according to the nature of the exciting cause, whether moral or physical, whether natural, morbific, or remedial, and equally so in animal and organic life; passing over, in the fulfillment of this law, various intermediate nerves of more direct anatomical connection. This is remarkably exemplified in many musical performances and feats of agility. This special determination of the nervous power is most in conformity with the special influences that may bring it into operation, in healthy conditions of the body; but in diseased states, or where organs are but partially diverted from their natural state, a direction is more or less given to the determination of the power by these acquired susceptibilities (§ 500 *j*, *k*, 903). This peculiar attribute of the nervous power distinguishes it from the direct action of remedial and morbific agents, which, if taken into the circulation in efficient quantities, would often derange the universal body. But the same physiological constitution of the nervous power which renders it obedient to the will in its transmissions to particular muscles, or to the passions in its effects on special organs in organic life, renders the power, when modified by remedial or morbific agents, and according to its precise modification and susceptibility of parts, equally determinate and circumscribed in its operation (§ 150–152, 838, 844). There is nothing in Nature more wonderful and paradoxical than this attribute of the nervous power; and while the facts which it supplies in connection with the operation of the will and the passions bear with the strongest analogical force upon the philosophy which respects the influences of morbific and remedial agents upon all parts distant from the seat of their application, that analogy is corroborated by the limitation of the morbific or remedial effects to certain parts of the organism. The fact may be regarded as fatal, in itself, to the doctrine of the operation of morbific and remedial agents by absorption, and to the hypothesis which identifies the nervous power with galvanism.

GENERAL REMARKS UPON THE PHILOSOPHY OF LIFE.

234, *a*. Notwithstanding all the laws of sympathy, that are necessary to the full interpretation of the remote effects of morbific and remedial agents, are as well established as any laws in physics, they have not been applied to these important objects; but, on the contrary, those philosophers who have contributed most to their critical exposition, overlook their pathological and therapeutical bearings, and cling to the doctrines of humoralism, and of the operation of remedial agents by absorption; nor have they applied, in the least, the nervous

power in a philosophical manner to an exploration of the natural phenomena of sympathy. The oscillations of Newton, the contractions of Darwin, the vibrations of Hartley, the secretions of Galen, the galvanism of Galvani, the destructive forces of the chemist, and the caloric and the magnetism of wilder imaginations, continue to be adopted, and show as well by their great incongruity as by their failure, that the hypotheses are founded on imaginary data, and that each has neglected the phenomena of life (§ 189 *b*, 785).

234, *b*. I say nothing of those who still refuse their assent to the well-ascertained laws of sympathy, as manifested in the natural states of the body. These they have yet to study and to learn; but it may be well objected that their ignorance shall prove an obstacle to the progress of knowledge.

He, indeed, must have been a very imperfect spectator of human events, who anticipates the acquiescence of ignorance or prejudice, or the ready concurrence of inferior minds, in the intricate problems which relate to the laws of the vital functions. The demonstrations of Philip have become obsolete, in all but their abstract nature; and the discoveries of Prochasca, Sir Charles Bell, Müller, Hall, Valentin, and others, in the functions of the nerves, are either unknown, or unappreciated, by all but the erudite student or such as aim at erudition; and the very anatomical medium of sympathies, through which the operations of the nervous power and the phenomena of sympathy appeal, as it were, to the *senses* as well as to the understanding, is apt to be regarded as an accidental or as a superfluous appendage of the body, or thrown in to embarrass inquiry by multiplying the complexities of organic beings.

Coming to the different kinds of irritability and sensibility, or as these are modified by morbific and remedial agents, or by other physical causes, as well as the analogous modifications of the nervous power, and its remarkable attributes as a vital agent, its direct action as such when developed by causes acting directly upon the nervous system, or when brought into operation indirectly through the medium of sympathetic sensibility (§ 227), and other analogous facts which are equally substantiated by an endless variety of phenomena, they are pronounced by a no small number of the profession, even by writers who appear in the character of expounders of medical philosophy, as metaphysical speculations, or as imaginary hypotheses. Even life itself is regarded as a subtlety of the schools, or as a phantom of less reputable claims. "For my part," says Magendie, "I declare boldly that I look upon these ideas about vitality, and the rest of it, as nothing more than a cloak for ignorance and laziness."*

234, *c*. If, then, you object to the existence of a principle of life, why not to the existence of mind, to the imponderables, or to tangible matter itself (§ 168, 169, 175 *bb*)? Do you deny its several well-attested properties? Then why not deny the properties of the mind? Have you not, for the aid of the senses, a tangible analogy in the solar beam (§ 188½ *d*, 234 *e*)? Do you cast aside all the phenomena of irritability and sensibility, and maintain that the action of internal and external causes, the mind and its passions, is exerted upon the structure alone, because you cannot see the properties (§ 169, 189)? Can

* See *Medical and Physiological Commentaries*, vol. i., p. 397, 511, 512, 514, 515, as to Magendie.

you see the Maker of the eye, or did the eye make itself (§ 74)? Do the muscles move without a moving power? Are you not amazed at what you cannot deny, that the mutual co-operation of the mind and the brain, which results in *willing*, is limited in its action upon the body to exactly those parts where its operation can be alone useful to the animal, namely, the voluntary muscles; nay, more, that the will elects of these muscles such only as are precisely necessary to its present purpose, and bestows every imaginable degree of force within the limit of its power, and variously, also, on the several muscles which it may throw into simultaneous action (§ 233¾, 349 *e*, 500 *i*)? Is there nothing as improbable in all this as in the propositions of the vitalist? Consider how, on the other hand, those other acts of the mind, called the passions, so near akin to the will, judgment, reflection, are clearly ordained to operate in organic life for the moral and physical good of the being; or, if they be also the causes of pain and disease, the analogy of Nature shines out even here in placing them on a par with the remedial agents of the external world. If this be so, or a single fact conceded, how will you disregard the multitudinous phenomena of irritability and sensibility, or their various natural and artificial modifications (§ 64, *f*)? Will you consider an *argumentum ad hominem?* Do you, then, deny that you possess judgment, reflection, and the ability to discover truth? If you object not to this, you must concede the philosophy of these Institutes as to the foregoing properties of life, and by the same demonstration upon which that philosophy rests you must admit the imputed attributes of the nervous power, which are far more clearly and variously attested than judgment, reflection, or the ability to discover truth. Look at the experiments by Wilson Philip, Hall, Müller, Bell (§ 464, &c., 476, &c.). Look at the nervous system, and there you shall absolutely *see.* Or, do you require other aid for your *senses*, look, again, at the analogies which are supplied by the solar beam, by electricity, by galvanism, by magnetism. Consider how they astonish you in their overpowering influences upon all things but the living being. And yet you can not *see* how these destructive effects are exerted. You give up your senses when the needle traverses the compass, and stand in mute astonishment, gazing at the north for some sign that shall help the understanding as to the nature of the mysterious agent. But you *see* and *feel* nothing. Nor is this all; for the dismay of sense becomes inexpressible, when imagination surveys the interval of thousands of miles, through which the unseen force exerts its mystic sway. And so of gravitation. But the effects are strongly pronounced upon the sense of vision, and their frequent repetition begets an acknowledgment that there is something besides the tangible and visible qualities of matter which, operating through vast distances, maintains the needle in one everlasting direction, and the heavenly orbs in their undeviating rounds. And here, in the perpetual operation of magnetism, there is something to aid your conception of an equally unintermitting exercise of the nervous power.

234, *d.* Do you object to what I have propounded as to the artificial and temporary modifications of the nervous power (§ 227–232)? Can you state an objection, farther than that which has been just considered? Do not the infinite phenomena of sympathy mutually conspire together, without a contradictory fact, in proving the occurrence

of such modifications; and is there a single effect of morbific and remedial agents, operating through the nervous systems, which cannot be clearly, perfectly, explained by the doctrines which I have propounded in relation to the nervous power? Can a like affirmation be made of any other thing? But, you cannot *see* the modifications of the nervous power. Neither can you *see* the modifications of the electric fluid, as manifested under the conditions of electricity and galvanism; but, the effects of the latter make a strong impression upon sense, which grows into the belief that physical causes do, in reality, alter the conditions of electricity and turn it to galvanism, and those effects have actually engendered the expression of "modification of electricity." Here, then, is something for the senses, to aid them in their survey of the less tangible, but not less precise, and infinitely diversified, phenomena, that mark the artificial modifications of irritability, sensibility, and the nervous power. And, should you require a like assistance as to the natural modifications of irritability and sensibility, or even the existence of the different properties which appertain to the vital principle, you have only to regard the solar beam, and the solar prism, and try experiments with each prismatic color (§ 188½, *d*).

234, *e*. Do you marvel at the rapidity with which the nervous power moves in its operations? Consider, then, the incomprehensible velocity of light,—200,000 miles in a second of time; or the more rapid apparent motion of the electric fluid. Or, take the more probable doctrine of the undulations of light, and this will be yet more conformable to what is probably true of the nervous power. Of the undulations, then, we have not less than 458,000,000,000,000, for the red ray; 535,000,000,000,000, for the yellow ray; 727,000,000,000,000, for the violet ray, in a second of time.

I say, when we think of the physical effects of electricity, galvanism, magnetism, and of light, and more especially when we attempt to think of the inconceivable rapidity with which the undulations of light are propagated, we shall have no difficulty with what I have attributed to the nervous power in resolving the phenomena of sympathy, voluntary motion, &c., and when, also, we reflect that those very undulations, according to their variety, produce on the retina all the impressions that are requisite for every phenomenon of vision, and that every impression, which is thus produced, must be transmitted to the brain, before the sense of vision can be excited (§ 188½ *d*, 500 *k*).

If, also, the retina be thus sensitive to the undulations of a substance which is so imponderable that it is doubted by many whether the substratum of light be actually material, we shall have no difficulty, I say, by the aid of this plain analogy, in making the same philosophical use of the vastly more numerous and unique facts that are supplied by animal life, or in apprehending that the virtues of more substantial agents, whether morbific or remedial, may, in like manner, exert powerful impressions upon the properties of every part, both nervous and organic, and that such influences may, equally with the impressions of light, be transmitted to the brain and spinal cord, and establish impressions upon the parts in conformity with the virtues of each agent (§ 503).

The undulations of light are excited by the various objects from which they proceed. And so of the nervous power. It is not *in tran-*

situ, a movable substance, but, like the principle of light, is every where diffused through its appropriate medium, and, like that principle, is brought into operation by exciting causes. Is it difficult, however, to imagine how the nervous power can move with the velocity of light in parts so dense as the nerves? It is less difficult than the comprehension of the admitted fact that light traverses the diamond as rapidly as it does ethereal space (§ 175 *b*, 188½ *d*). Do you still marvel as to *how* the nervous power should induce or subvert diseases? Were you not equally in the dark as to the *modus operandi* of the solar beam in its various agencies upon inorganic compounds, till a few obscure phenomena led to the hypothesis of undulations? But, what have you gained by the undulations? Can you tell us how these inconceivably small motions operate, without a resort to absolute assumptions? Are you any more convinced than before, that the phenomena of light are realities, or have you been aided a whit, by these discoveries, as to your former knowledge of the laws of light? You tell us that not only the well-known colors of the solar spectrum possess, individually, specific properties, but that "each of these comprises rays differing in constitution, and differing in refrangibility, and that, doubtless, to each one specific effects are due."* You show the physiologist a few positive results, and he believes the analysis, and the existence of the several rays; though he may greatly discredit your philosophy of the effects as manifested in a department of nature which you only study under influences supplied by the laboratory (§ 188½, *d*). But, you tell him, also, that the solar ray embraces "other principles which are *invisible*," and you call upon him to admit the existence of these, notwithstanding he cannot *see* them (§ 175, *bb*). The physiologist, however, readily admits their existence upon the strength of the few facts which imply the operation of an invisible agent; and he does so because he is a physiologist. But, taking your own rule of judgment as to a vital principle and its several properties, you were doubtful whether he might demand more tangible proof; and, accordingly, you prepare him for an admission of your premises by a mode of reasoning which you reject, contemptuously, when the physiologist sets forth his endless series of facts which prove, each one, the existence of properties peculiar to living beings. You prejudge the case, as it were, by impugning his understanding, unless the induction be conceded. You tell him, that, "just in the same way that I am willing to admit the existence of forty simple metals, so, upon similar evidence, I am free to admit the existence of fifty different *imponderable* agents, if need be" (§ 188½, *d*). The physiologist requires you to admit but one, and, with this one he explains, with perfect consistency, all the processes of living beings, all the phenomena in physiology, in pathology, and therapeutics, while no one of them can be interpreted without the agency of such a principle.

234, *f*. But again, I say, what have we gained in a practical sense, or as to the modus operandi, or the laws of light and heat, or of the constituents of the solar ray, by the discovery of the undulations, or by any supposed decision of the question as to distinct rays or modifications of a common ray, or even by the prismatic colors? Nothing whatever; no more than has been gained, in a useful sense, by microscopic explorations in physiology, but with the greater advantage

* Draper's Treatise on *The Forces which produce the Organization of Plants*, p. 103.

of more precision, and more accomplishment to science, and without the pernicious hypotheses of the latter. And can the same affirmation be made of our knowledge of the properties of the vital principles, and of their natural modifications in different parts, and those which are induced by morbific and remedial agents? On the contrary, we see this knowledge every where converted to the most important uses of organic beings, not only in a direct practical sense, but in unfolding the great laws by which they are governed. This knowledge, indeed, is the great foundation of physiology and of the healing art.

Do you object to the relation which sympathetic sensibility bears to the nervous power (§ 201), and the relation of the nervous power to irritability (§ 226), in the phenomena of motion? Have you any better data for your conceptions of the relation of the magnetic pole to the needle; and to explain that relation, do you not admit a peculiar imponderable, invisible agent, which acts upon the properties of the needle? Do you understand any better, or have you any better facts respecting, the relation of physical agents to the mind, in the phenomena of sensation? You obtain your ideas of *matter* through the operation of physical agents upon the intellectual part; and how will you explain the access of those physical means to the spiritual substance unless you also admit the physiological property, sensibility? What intelligible connection is there between the properties of mind and the motions of the brain? What intelligible connection between the stimulus of the blood and the motions of the heart, or those motions which attend the generation of bile and all other organic products, unless you admit a principle of life? The forces of life are concerned about sensation in a peculiar manner, and there would be a violent interruption of the law of analogy were there not something intermediate between mind and matter, a bond of union, as it were, through which impressions upon the senses should reach the spiritual existence. We may fancy it to be electricity, or the chemical forces; but, this no more aids our comprehension, through the known phenomena supplied by these causes, as to the communications from matter to the immaterial, thinking existence, than if we regard the nerves, *per se*, as the only medium. We therefore turn our reason to the special phenomena, and find a property in universal operation throughout the body, as the medium through which certain kinds of impressions from physical agents are transmitted to the mind. But, we find, also, another analogous series of phenomena which force us to the conclusion that these depend, also, upon a certain modification of the same property as that through which impressions are made upon the mind by external objects. We see, also, that these transmitted impressions give rise to another endless series of peculiar results, which have their point of departure in the nervous centres; and we see, too, that each one corresponds with, and confirms the others, in the several series respectively. We learn, besides, that those of the last series are analogous to the direct effects of vital agents, healthy, morbific, and remedial, upon the organs which are the immediate seat of their operation. Hence, we conclude, inevitably, that there exists what is denominated the nervous power, with all the attributes which I have ascribed to it, and that it is brought into operation through the same channel of sympathy as the mind when sensible objects exert their effects. The mind, and the nervous power, are, therefore, so far on a

par. Each is an agent, each gives rise to sensible and insensible motions, and modifies variously the ordinary results when themselves are affected in an unusual manner, and each are brought into operation by analogous causes. The mind, through the properties of life, forms a special bond of union between itself and certain parts of the organization; the nervous power, another special bond between the same properties of the vital principle, and other parts of the organization, and by which, and by the perpetual operation of that power, the whole organic mechanism of animals moves on in a well-balanced, concerted action. Thus are the properties of the mind, the properties of the vital principle, and the sensible mechanism, all mutually related to each other, and bound together by laws as precise as those more simple ones which rule in the inorganic world.

234, *g*. We need not, therefore, inquire into the intrinsic nature of the nervous power, or of the organic properties. It would be as absurd as to interrogate the nature of gravitation, or of any other property of mere matter, or even matter itself; though we may well say what the nervous and organic powers *are not*, and thus save much speculation and its resulting practice. It is enough that we know their existence and the laws they obey. This is all that can be philosophically or practically useful. With these we are about as well acquainted as we are with the laws of gravitation, or of light. An ignorance of the *nature* of the principles or causes affects in no respect our study of their laws, of their modes of operating, or of the influences to which they may be liable. Their laws, like the laws of galvanism, or of optics, must remain the same, whatever theory may be adopted as to the *nature* of the causes.

Inquiries, therefore, so obviously beyond our reach as the absolute nature of the vital principle, or any of its properties, should never raise our curiosity, much less receive our attention. Their pursuit vitiates the judgment, diverts the mind from practical and useful inquiries, and renders it prone to speculation.

But again, I say, we know enough of the whole of this subject for the purposes of philosophy, and for the good of mankind, by the phenomena alone; and since the phenomena of organic beings are far more diversified than those which relate to inorganic matter, so also should we be as contented with the former as with the latter, and apply them in the same philosophical and practical manner. We also know enough of physics to marvel at nothing in organic beings which may be utterly different from the constitution, the phenomena, and the laws of inorganic matter; and, if it seem mysterious that such an agent as the nervous power should exist, with the characteristics which I have assigned, it will become less wonderful when we reflect upon the phenomena of the immaterial mind in its connection with organization, as in muscular motion, blushing, palpitation, syncope, apoplexy, &c., or even upon the velocity of light, the inconceivable rapidity of its undulations, its laws, its effects, &c.

All that we can know of the nature of any substance, material or immaterial, is by the phenomena it manifests. Where these are the same, or closely allied, as in electricity and galvanism, we may be sure that the essential causes are the same. But, where great and striking differences exist, and more especially where there are no analogies in the phenomena, as between the nervous power, or the

organic properties, and all inorganic agents, substances, or causes, we may be equally certain that the agents, substances, causes, or powers, are as different from each other, in their essence, as in their phenomena.

It follows, therefore, that the nervous power, and the organic properties, are, respectively, *sui generis;* having no analogies in the inorganic world.

The phenomena which different agents, powers, or causes, manifest, are so unlike each other, that different modes of investigation must be pursued to arrive at a knowledge of each; and the phenomena will be just as conclusive of the nature of one substance or power as of another. A stone, for instance, affects the sight, and touch; it appears of a certain size, shape, color, &c., or it is hard or soft; if analyzed, it is found to be composed of several distinct substances, each of which manifest other phenomena; and this is all we know of the nature of a stone. And so of magnetism, galvanism, light, heat, and whatever else appertains to the inorganic world. We examine their manifestations, and compare them together, and distinguish different things from each other by the manifestations or phenomena of each. But, there are groups of phenomena which have certain general resemblances, and these we arrange into genera or families, as the several earths, metals, gases, &c.; but the specific distinctions always remain, so that by the phenomena peculiar to each species we can always distinguish one from another. Just so it is in respect to the physical and chemical powers. The means of knowledge are of the same nature in all the cases, and the proof is as good in one case as in another.

Coming to plants and animals, a general survey of their phenomena shows us that they have no other analogies, of any importance, with the inorganic world, than in the elements of which they are composed. These are derived from the inorganic kingdom; and here the similitude ends. If we investigate the phenomena analytically, they come upon us in a profusion wholly surpassing those of inorganic beings, and without the most remote resemblance. Here, therefore, we apply the same rule as to inorganic beings, and we learn by the same process of observation, as much of the nature and powers of one class of beings as of the other, and the proof is as good in one case as in the other, though more conclusive in respect to organic beings, inasmuch as their phenomena are more various. By the same rule, also, we attain all the knowledge we possess of the soul, and, beyond that of Revelation, all that is relative to a Supreme Being; and we distinguish each from all the others, or bring them into relationship, in the same way.

The same mode of reasoning is, of course, applicable to what I have said of the modifications of the nervous power (§ 227–229), and of the organic properties (§ 133–156, 188–215).

234, *h*. We are, however, so much the creatures of sense, that the majority will probably still go on explaining every thing appertaining to life by some tangible or visible cause, or by some laws with which we fancy ourselves to be better acquainted. I have already cited several examples; and if we take up any writer, indifferently, it is more than an equal chance that the authorities will be increased. Thus, here is Sir Gilbert Blane's excellent work on "Medical *Logic*."

"The changes," he says, "accomplished by the actions of life may be conceived to be effected through the agency of some imponderable fluid; such as electricity, light, or magnetism. We may conceive, for instance, that each gland may be furnished with a sort of voltaic apparatus for effecting its specific change." The same doctrine has been adopted by a host of medical philosophers of our own times. But, did any of the foregoing agents ever produce, out of the organic being, a single one of the phenomena of life? Did they ever give rise to one of those phenomena in a dead subject, although the organized structure remain unimpaired; as in cases of instant death from hydrocyanic acid, nux vomica, or from a needle thrust into the medulla oblongata? Is not the whole hypothesis contradicted by all that is known of the effects of those agents? It is the merest assumption to sustain an unintelligible and absurd hypothesis, to affirm that structural derangement is necessary to death. If galvanism, the chemical forces, &c., be the immediate cause of the deposition which constitutes the interstitial growth, what bestows vitality (or life, if it be preferred) on the new-formed matter? Or, if this vitality be imparted by specific powers of the formative instruments, why should not those powers be adequate to the entire work (§ 64)? Why so great a violation of the most common rule in philosophy, as to introduce other forces, whose great office is to pull down, and whose results are confusion?

234, *i*. The whole art of medicine consists in producing certain impressions upon properties or powers that are wholly unlike those which rule in the inorganic world. It will not answer to talk of modifying the operation of galvanism, magnetism, gravitation, light, chemical affinity, &c., by an emetic or cathartic. It must, however, come to this, if you will have it that those forces preside over organized beings, or even if they be allowed to have a subordinate agency (§ 175, *d*).

235. Finally, the phenomena of life are as easily comprehended as those of inorganic matter, and denote as clearly, and even more so, the nature of the causes. Who will demonstrate the nature of those physical properties by which foreign agents produce their impression on the properties of life? And yet so accurate is our discrimination among them, as prompted by the vital signs which they produce, that it is one of the most important objects of the physician to select from the multitude of cathartics, emetics, &c., a certain species whose properties shall correspond with the modified signs of the properties of life; and, it is no unusual phenomenon, that, of the whole range before him, he decides with accuracy that there is only one medicine which is well suited to the case. And his conceptions of the specific properties of the agent, and of those of the organization, even in the modified state of the latter, are so comprehensive, that he may foretell their united result. He knows as much of the properties of life as of the remedial agent. He knows them far better; and that he admits their existence and specific nature is manifest from his deliberate action. Whoever prescribes for disease upon any other ground is a mere charlatan.

Who, again, will define the nature of cohesion, gravitation, chemical affinities, &c.? Like the properties of life and of spirit, and their relations to matter, their existence is only inferred from certain uniform phenomena, and from such, alone, we deduce their relations to

objects of more sensible demonstration; and this is all we know of the sensible objects themselves. We reach the connection between common matter and its properties, between the vital properties and organized structure, between the intellectual and moral faculties and the nervous system, the concurrence between them in the production of certain effects, and the differences in the nature of the several properties, by a common process of observation. There are mysteries attending the same conditions of the whole which must be left to the sole comprehension of the Author Who intended the whole to subserve the purposes in which we are alone interested; Who has wisely secured to Himself the nature and control of primary causes; and Who has thereby restricted our inquiries to the only useful end of knowledge, the existence of the causes, and their various phenomena and laws. These may be so employed, as to answer the wants, the conveniences, and the various exigencies of intelligent beings. Those are the springs of action which it might be unsafe for man to understand.

236. From what I have hitherto said on the subject of life, it must evidently be regarded, in a philosophical sense, as a *cause*, not as an *effect*. The functions and other phenomena are the effects. This construction, which I have also set forth in my Essay on the "Vital Powers" in other demonstrative aspects, is indispensable to any sound principles in medicine. All effects have their causes; and this simple principle obliges us to look for a *cause* of the phenomena of life. It is with the conditions of that cause, ascertained through the medium of its effects, that all physiology and medicine are concerned.

237. The powers by which living beings are governed, *cæteris paribus*, are always as precise in their operation, and bring about results as precise, as gravitation itself. But the properties of life are constantly liable to variations, and, therefore, there will be corresponding variations in their phenomena. Gravitation, and other physical forces, on the other hand, are immutable, and there are, therefore, no variations in the results of their operation. But it is also equally true that any given condition of the properties of life, connected with any given influences, is equivalent to the unvarying state of the physical forces. That particular condition, in conjunction with the supposed influences, always determines the same results, whether in health or disease. Every power in nature, when operating under given circumstances, always terminates in uniform effects. The uncertainties, therefore. to which the science of medicine is liable, or any other which has nature for its foundation, are owing to our inability to understand all the facts. If any remedial agent produce an effect at one time which it does not at another, it is because the properties of life have been differently affected in the different cases; and there may have been, also, a concurrence of many other different influences. Nevertheless, in each case, the medicine operates according to established laws, and the modifications depend upon the difference of circumstances. Each combination of circumstances, however, always gives a uniform determination to the laws which govern the effects. Where the conditions are the same, the remedy in a certain dose will always produce the same results.

Although gravitation is immutable in its nature, we yet see something analogous to the foregoing influences upon the properties of

life, in the manner in which the revolution of the heavenly bodies may be affected by their interference, in relation to each other, with the power as exercised by the sun; as seen in the erratic movement of comets. In either case the incidental influences may be calculated, and the results foretold,—conforming, in one case, to the laws of gravitation, and in the other to those of the vital force. The stability of the physiological conditions enables us to calculate not only what will happen to-day, but through all future time. But, the vital conditions are subject to precise modifications at the several great eras or stages of life; but, being marked by uniformity, the results are forever the same, at each era respectively. The fundamental changes enable us, also, to foresee how the modified properties of life will be differently affected by vital stimuli, the new sympathies that will spring up, the different relations of sensibility to the faculties of the mind, the difference in the acquisition of knowledge, &c., at the several eras. From these natural and uniform modifications of the vital states, we may turn to those of a fluctuating and accidental nature, which grow out of the influence of climate, habits, employments, &c., and which may be not only as lasting as the individual, but may be transmitted to his posterity. As at the different eras of life, we here find, also, variable influences from the natural, the morbific, and the remedial agents, variable sympathies, &c., among organs, according to the artificially-modified condition of the properties of life. These conditions, however, are rarely exactly the same in any two individuals; but, they are strictly analogous in principle to the natural ones which distinguish the several stages of life, and, so far as they may be known in any given case, we may calculate, with great approximation to the truth, what will be the special characteristic phenomena that will mark the organic, the animal, and the intellectual existence of that individual (§ 153–156, 535, &c., 574, &c.).

Thus we have a series of analogies, in respect to the mutability of the properties of life, and corresponding results, which bring us upon the confines of disease; which consists, also, in certain modifications of the vital properties, but more profound, more various, and more transient (§ 176–182). Here lie the difficulties of medicine; difficulties attending our knowledge of the modifying causes, the influences they produce, the complications of sympathy, and other contingent circumstances. All these conditions must be known in any given case, to foresee, with certainty, any immediate or more remote result either of disease or of the action of any medicine, or of any natural vital agent. But, the properties of life being never very greatly varied from their natural character, we may come, by a careful observation of their varying phenomena, to a knowledge of their conditions, and to foresee the results, or such as may spring from the operation of medicine, from the different kinds of food, &c., with sufficient accuracy for all useful purposes. With this knowledge, we get at the most important laws of disease, general and specific, and build up principles which are more valuable in practice than ages of disconnected experience (§ 149, 150).

238. I have said, that although instability is a prominent characteristic of the properties of life, and lies at the foundaton of disease and therapeutics, these properties never undergo any radical change till they shall have lost their recuperative tendency. They are the only

attributes of organic beings that do not undergo absolute change and renewal. These properties must be forever present, without essential change of their nature, to carry on the work of decay and renewal, which are in perpetual progress in all the solids and fluids over which the properties preside.

Hence an important law, that all hereditary predispositions to disease, and all impressions from morbific agents, which do not produce their manifest effects till the blood shall have undergone a renewal (as in hydrophobia, fevers, &c.), must be primarily exerted upon the properties of life, and that all the subsequent changes in the fluids and solids must be due to that original modification of the vital properties. To perpetuate the primary influences, something of a permanent nature must receive the impression. Analogy, alone, would assure us that this must be also equally true of the effects of all morbific and remedial agents.

239. There is nothing more important to be known and appreciated, than the endowment of the properties of life with a tendency to return from diseased to their natural states. This is the *vis medicatrix naturæ*, and is the immediate foundation of therapeutics. This, and this alone, has given rise to the art of medicine; since, by no artificial means can the diseased properties and functions of life be converted into their healthy state. It is also remarkable that the most efficient remedial agents institute their favorable effects by establishing new pathological conditions; which farther shows that it is nature alone which cures, and through the foregoing principle. That principle is one of the most remarkable exemplifications of Design, since, without it, the human race would become extinct.

240. Connected with the foregoing law is another not less fundamental, and which shows the fallacy of reasoning from the effects of remedial agents upon healthy to morbid conditions. It is, that the susceptibility of all parts to the action of remedies, physical or moral, is very different in disease from what it is in health, and the nature and the results of the influences are greatly different in the two conditions. Take many of the most powerful agents, arsenic, tartarized antimony, iodine, &c., and when administered in certain small and repeated alterative doses, they bring about the cure of the most obstinate and formidable conditions of disease; while the same doses may not manifest any action upon the system, or on any part of it, under circumstances of health. This manifestly depends upon an increased susceptibility of the organic properties, in their diseased conditions, to the action of foreign agents, and upon an increased disposition to undergo changes. And here we have opened a grand display of infinite Design, Wisdom, and Goodness, to mitigate the penalties of disease, and to preserve the human race. This law, which unfolds a principle latent in health, and by which morbid organic properties acquire susceptibilities to salutary influences from agents which in health would either produce no effects, or lead to untoward results, and its ally, the great recuperative principle (§ 239), impose the highest obligation on physicians to become medical philosophers

7. THE MIND AND ITS PROPERTIES.

241, *a*. Reason and instinct belong to man; instinct alone to animals. Mind is commonly regarded as synonymous with reason, and

instinct a principle by itself. The latter is undoubtedly true of animals; but I would consider instinct, in relation to man, as a property of the soul; while in animals it is shorn of the great distinguishing attribute of man, the rational, immortal faculty. Independently of the specific facts which go to this conclusion, it has the strong ground of analogy in the more complex condition of the principle of life as it exists in animals than in plants (§ 184, 185).

241, *b*. To simplify the discussion of this intricate subject, the word *mind*, with the foregoing explanation, and *mental properties*, so far as perception, the will, and the understanding, are concerned, may be applied indiscriminately to man and animals. Judgment and reflection are the great characteristics of reason; but, contrary to the usual representation, the understanding belongs as well to the instinct of animals as to the human mind. Many, again, may be disposed to consider the understanding a function, rather than a property; but this construction would suppose the operation of judgment and reflection, which do not belong to animals. The term is also employed in other acceptations than the present.

241, *c*. The abstract manner in which metaphysicians have considered all the operations of the mind, while no one of them is performed without the co-operation of the brain, or a principal nervous centre, and originally elicited through the corporeal senses, proves to us that physiologists are best qualified to analyze the phenomena of the soul and of instinct, and to indicate their relations to the body, and the laws which they observe. There is also a mysterious affinity between the soul of man and the instinct of animals, of which metaphysicians take but little or no cognizance. This alliance is shown by the corresponding manifestations of perception, of understanding, and of the will in animals; by the amazing precision with which their habits are regulated; by the evidence of common passions; by the coincidence in the external senses of man and animals, through which they alike acquire a knowledge of external things; by the parallel in the anatomical structure of the brain of man and of animals which stand high in the scale; and by other analogies, which denote an affinity between the soul and instinct So great and various, indeed, are the evidences of the foregoing nature, that the special attributes of instinct are associated with the human mind; thus forming a connecting link, through the moral faculties, between rational and irrational beings.

Nevertheless, the phenomena of the human mind are infinitely superior to those of instinct, while the operations of instinct in animals greatly surpass any of its manifestations in man. Many special peculiarities concur, also, in demonstrating an absolute distinction between the rational mind and instinct. The latter, for instance, always moves, in each individual species of animal, in a particular, unvarying path, but differently in each species of animal.* It never diverges to improve its original endowments, or to add a gain which it did not possess in its infant condition. It is then nearly as perfect in its operations as at mature age; nor does one generation of animals gain upon its predecessors. How different with reason, and with the instinct of man! He passes through early infancy without a trace of the former, and with only that helpless development of the latter which ena-

* Here I may say *that analogy proves that there is but one species of mankind, since the manifestations of reason and instinct are the same in all.*

bles him, with the foreign aid of reason, to imbibe the sustenance required by organic life. Unlike the instinct of animals, however, the corresponding manifestations become greatly multiplied as age advances; but it remains always far more circumscribed and imperfect, and often plunging itself, and leading reason, into violations of their natural functions. And what a contrast between the limitations of instinct and the progress and grasp of the human mind; the latter forever ranging through all the labyrinths of nature, investigating their phenomena, developing their powers, their subsidiary causes, and their laws, turning in upon itself and multiplying its knowledge, and enlarging its powers by its own independent efforts, laying up the gains of the past as a fruitful source of present good and of farther acquisitions, distinguishing good from evil, from which results the sense of moral responsibility, investigating its own attributes, and attempting even its own nature, and tracing up its existence to a Higher Power, as the Author of the Universe which was made for the contemplation and the enjoyment of mind (§ 175).

241, *d.* It is not an object, however, of the Institutes to investigate the philosophy of mind beyond those physiological considerations which are relative to the properties and functions of life, however it may have been important to their interests to contradistinguish the Maker from His works (§ 14 *c*, 175, 350¾ *h–l*). *Perception* and the *will* are the only mental properties which concur, more or less, in the phenomena of animal life.

242. *Perception* is always necessary to true sensation, and therefore to the exercise of all the senses. The mind, or instinct, must perceive an impression made upon sense, and consciousness must operate before the impression can be realized. The phenomena of sympathy in their connection with sensibility, in the ordinary processes of life, are not relative to sensation, but depend on a special modification of sensibility and on the nervous power.

243. The *will*, another property of the mind, upon which volition depends, exemplifies yet farther the complexity of the principles which obtain in the animal kingdom; and its phenomena admonish us to pause over that materialism which sees nothing but the demonstrations of physical and chemical power in the equally unique manifestations of irritability, sensibility, mobility, the nervous power,—the entire organic force (§ 215).

The will presides in animal life. It governs the movements not only of the voluntary muscles, but even the operations of the other mental faculties. In producing muscular motion, the operations of judgment and perception are often associated, and even bring the will into action. All muscular movements with which the mind, or instinct, is not connected, depend upon other causes than the will. Voluntary motion is, therefore, as dependent on the will, as true sensation is upon perception.

The will has little or no operation in organic life (§ 500, *e*); though the passions operate with power upon the heart, the abdominal viscera, &c. This peculiarity is founded in consummate Design; since greater latitude to the will would be incompatible with animal existence; while, on the other hand, other elements of the mind are allowed, for useful purposes, to stretch their influences to the deep recesses of life.

244. The will, a property of the mind, like the nervous power a

property of the vital principle, is, therefore, a vital stimulus to the brain, whose chief office is the production of voluntary motion, by bringing into action the nervous power.

245. When the will gives rise to voluntary motion, the philosophy is the same as when motion is developed in the organs of organic life by the nervous power (§ 205–215). The latter may take place through impressions transmitted to the nervous centres (§ 227, 500), or by impressions exerted in a direct manner upon these centres (§ 227, 230, 477). The will operates in the direct manner, develops the nervous power, and transmits it to the irritability of the voluntary muscles, by which mobility is brought into operation (§ 233). When the passions affect the movements in organic life, it is exactly in the same way as with the will in animal life (§ 500, *h*).

246. Thus it appears that the unity in the great plan of the nervous power, in its relations to both organic and animal life, to mind as well as to matter, and the perfect concurrence of all the facts, and the obvious nature of the whole, which declare a harmony of principles and laws throughout all the immense variety relative to the nervous power, continue to unfold a grandeur of the subject which invites an unprejudiced attention to the expositions I have made of this brilliant institution of Nature.

FOURTH DIVISION OF PHYSIOLOGY.

FUNCTIONS.

247. Our fourth grand division of Physiology comprehends the functions of organic beings. They are carried on by the properties of life in their connection with organized structure (§ 170, 175, 177), and of which the functions are the great final causes, or effects (§ 176). They are, indeed, the only useful ends of life; since, otherwise, all organic beings would exist in the condition of the seed and egg (§ 235, 236). The terminating series of the capillary vessels are the immediate instruments of all the essential processes in organic life, and therefore, also, of all diseases (§ 109, 668, 679).

248. The functions are *common* and *peculiar*.

249. The common functions belong to all organic beings. They consist of, 1st. *Motion;* 2d. *Absorption;* 3d. *Assimilation;* 4th. *Distribution;* 5th. *Appropriation*, or nutrition and secretion; 6th. *Excretion;* 7th. *Calorification;* 8th. *Generation.* The first seven are indispensable to animals and plants. The eighth appertains only to the species, and has no essential part in the organic economy (§ 97, 118–123).

250. The peculiar functions belong to animals only. They are,

I. Functions of relation; comprehending, 1st. Sensation; 2d. Sympathy.

II. Voluntary motion, and functions by which the mind and instinct act on external objects.

III. Other mental and instinctive functions.

I. COMMON, OR ORGANIC FUNCTIONS.

251. Organs which perform similar functions are very variable in structure in different orders of animals. The liver, for example, "is represented in one case by simple cæca, or blind sacs; in another by tufts of cæca; in a third by bunches of cells; in a fourth by a spongy mass; in a fifth by branched ducts ending in feather-like terminal twigs;" and so on, up to the complication of the most perfect animals. Nevertheless, they all secrete a very analogous fluid. And so of other organs and functions.

A due regard for the preceding facts must unavoidably reconcile every mind to what I have said as to microscopical explorations of the minuteness of structure (§ 131, 304, 306, 409, *l*).

252. Though structure be very various, there is a great analogy in the vital functions and their immediate products,—even between plants and animals. This is remarkably true of every individual part in the different races of animals, whatever its simplicity or complexity (§ 251). Hence, it becomes more and more manifest that the properties of life have a greater agency in the formation of organic products than the structure itself (§ 67–69).

1. MOTION.

253. Motion is the immediate result of the action of mobility or contractility, and was necessarily explained in describing that property (§ 205–215). It is the function by which all things acquire their movement in organic beings.

254. Motion may be remotely mechanical, as the movement of the blood, ingesta, &c.; but the power and the actions of parts which generate the mechanical movements are purely vital.

255. Motion belongs, of course, to every tissue in which its manifestations occur; and it is therefore an error, however common, to limit this function to the muscular tissue.

256. The great offices of motion in organic life are to supply the system with useful materials, and to remove such as are useless.

257. In animal life, this function appears under the aspect of locomotion or some analogous result, and I have associated the consideration of this modification of the function with that which is common to the organic life of animals and plants, on account of their common nature.

258. Voluntary motion proceeds from the action of the will upon the great nervous centre, by which the nervous power is developed and transmitted to the irritability of the voluntary muscles (§ 188, 208, 233, 476 *c*). Here the excitation of the nervous power is direct, as in the experiments by Wilson Philip (§ 486, 487). If the motion be involuntary, as in the ordinary movements of respiration, the development of the nervous power is indirect, according to the usual process when organic actions are influenced by the nervous power (§ 222, &c., 500). When other involuntary motions affect the muscles of animal life, as convulsions, &c., the development of the nervous power may be direct, as in diseases, and concussions, of the brain, or indirect, as in teething, and intestinal irritation. The philosophy, however, respecting the production of motion in all these cases, is exactly the same. Whether the movements be voluntary or involuntary, the

movements depend upon the action of the nervous influence upon mobility through the property irritability. The mind does not, as has been supposed, leave the brain to enter the muscles in voluntary motion. The difficulties of explanation are not only multiplied by this supposition, but it is shown to be erroneous by the analogous movements which may be excited through the spinal cord, or through the nerves, after the soul and instinctive principle are separated from the body by the removal of the head. This philosophy is also coincident with that which I have propounded as to influences of the nervous power in organic life. Each illustrates and sustains the other (§ 500).

259. It is now important to repeat, that the nervous power never generates motion, *per se* (§ 222–232). The function always depends immediately upon the organic property *mobility*, which is brought into action through impressions made upon irritability (§ 188). The nervous power is only a stimulus to irritability. But, it is much more important to motion in animal than organic life; since it is the only natural stimulus of the voluntary muscles, while blood, and other agents, are the natural stimuli in organic life. Indeed, the nervous power is not a natural stimulus to the viscera of organic life, but only superadded, in animals, for an incidental purpose (§ 215, 223, 226, 232, 455).

260. Very important laws grow out of the foregoing distinction between the relation of the nervous power to the function of motion in animal and organic life, and its essential independence of that power in either life (§ 476, &c.).

261. That motion does not depend upon the nerves, is shown by the sensible and insensible motions of plants; by that of their leaves, stems, stamens, by their absorption, nutrition, secretion, &c. (§ 455, *c*). The analogies in results prove this independence of the nerves, and the near identity of the function in plants and animals. Indeed, the chemists will have it that all the essential compounds of the animal are formed by vegetable organization (§ 18, 409). Such analogies are always sound, being based on great fundamental laws. But there may be great variety of mechanism. The same independence is shown by the organic actions which continue in parts from which all the nerves are severed; by the regular action of the heart and intestines after their removal from the body, &c.

262. "The heart of a frog continues to beat with its ordinary rhythm even when the entire base of the organ, when the ventricles, as far as their juncture with the auricles, are cut away."

In the same way, "the peristaltic movements of the intestinal canal continue not only when the intestine is removed from the trunk together with the mesentery and ganglionic plexus, but also when the intestine itself is isolated from the plexus by being separated from the mesentery at the line of its insertion."—Müller's *Physiology*.

263. Dr. M. Hall tied a ligature around the root of the heart and lungs, and then separated them from the body. "The action of the heart was still such as to carry on, in a slight degree, and for a short period, the circulation of the blood through the pulmonary artery, and a few of the capillary vessels." He adds his belief, "that the actual circulation of the blood has not been before seen proceeding entirely and independently of the sympathetic system."—Hall.

264. It seems also to have been shown by the case of the monster

recorded by Dr. Clark, that while the fœtus exists *in utero*, the nerves are no more necessary to its growth and maturity than are the glandular organs; simple nutrition being alone in progress. In that case, Dr. Clark had in view the importance of the principle now under consideration, and a faithful examination appears to have been made with a view to the nervous system, and which resulted in his failure to detect its existence (§ 461½).—Dr. Clark, *in Philosophical Transactions, London*, 1793, p. 154.

265. In the Medical and Physiological Commentaries I have set forth a variety of other important facts to show that motion, voluntary as well as involuntary, is essentially independent of the nervous system. (See vol. i., p. 17–29, 474–480, 571, 572; vol. ii., p. 385.) The Experiments of Philip are also conclusive upon this subject (§ 476, &c.).

266. The nervous power, in developing motion in either organic or animal life, as a stimulus to the organic properties, does not follow the nerves according to their regular order of distribution from the nervous centres. On the contrary, its entire want of uniformity in that respect—operating simultaneously, at one time, through a nerve or nerves proceeding from the cranium and some inferior part of the spinal canal, while it passes over all intermediate nerves—or, at another time, electing, without any regularity in respect to order of arrangement, two or more of those intermediate spinal nerves—this entire want of respect to anatomical order is so familiar to all that it has not appeared as one of the most difficult and sublime problems of nature. This very extraordinary attribute of the nervous power is rendered the more remarkable by our knowledge of the fact that its operation is determined through particular nerves either by an act of the will, or, in organic life, by particular passions, by their intensity of operation, and by the special nature and intensity of physical agents which may transmit their influences to the nervous centres through some other part; and, in the cases relative to organic life, according, also, to the existing susceptibility of the various parts of the organism (§ 473, no. 6).

267. All the foregoing are established facts, of perpetual occurrence; and they should be taken in connection with the doctrines which I have advanced as to artificial modifications of the nervous power, and the *modus operandi* of morbific and remedial agents (§ 226–232, 893, &c.).

2. ABSORPTION.

268. Absorption is performed, in animals, by the lacteals and lymphatics; those vessels being very similar in their constitution and function. There are corresponding means for the office of absorption in the roots and leaves of plants.

269. Magendie, and others who have copied from him, have fallen into the error of attributing the office of absorption to the veins. He was led into the mistake by an ignorance of the fact that the lymphatics terminate variously in small veins.* Fallacies of that nature should be apparent upon principle alone—at least to such as recognize a unity of design, and a simplicity in the great institutions of nature. Every system of vessels, so far as known, has but one func-

* See *Medical and Physiological Commentaries*, vol. ii., p. 170, *note*, 380, 394–396.

tion, however that may be modified in different parts, as seen in the lymphatics and lacteals, in the terminal series of the capillary arteries in all parts, &c. The distinction depends either upon structure connected with the modifications of common vital properties, and their relative adaptations to the physical properties of different fluids, or, structure may be apparently less concerned than the organic properties; which is one of the most universal and important principles in physiology (§ 133–150).

270. The lacteals perform the office of absorbing, and introducing into the organization of animals, foreign nutritive matter.

271. The lymphatics, on the contrary, are destined for the vital decomposition of the body, and for the removal of waste parts, which are conveyed by the lymphatics into the torrent of blood to be ultimately cast out of the system, or again to undergo, in part, the process of sanguification.

272. By these vessels, also, the solids are removed in the ulcerative process of inflammation, and mortified parts are detached from the sound,* and foreign substances which are introduced into the body are taken up and removed.

273. Hence it is obvious that the lacteals and lymphatics are antagonizing systems, and that organic beings are the constant subjects of waste as well as of nutrition; the balance being maintained through the inlet supplied by the lacteals, and the outlet provided by the lymphatics (§ 180–182, 286). Notwithstanding, therefore, the coincidence in the general function of these two systems of vessels, the office of one is creative, that of the other destructive.

During the period of growth, nutrition overbalances waste; but, when growth ceases, nutrition and vital decomposition must be *in equilibrio.*

274. No substances but such as exist in a fluid or very attenuated state are taken up by the lacteals and absorbents.

275. The lacteals have open orifices in the intestinal villi. I have shown the error of the microscopists who deny these orifices; and I have shown, also, that all vessels of secretion terminate in open orifices.† Physiologists, however, continue to copy the projectors of the mechanical theory of porous absorption and secretion.

276. Different substances are absorbed with various degrees of rapidity, both in animals and plants. This depends on their peculiar virtues, and on the manner, therefore, in which they affect irritability; thus showing the vital nature of the process (§ 149, 188, &c., 207). The same conclusion is also inferable from experiments, as well upon plants as animals.

277, *a.* Again, the lacteals, in virtue of their special modifications of irritability, exclude every thing but chyle. Bile is not taken up either by the lacteals or lymphatics; cathartics pass off; emetics are rejected. The principle is every where; is shown in the larynx, pylorus, &c., in the exclusion of the red globules from the serous vessels, though their diameters be many times larger than the globules of blood (§ 399). The principle lies in the virtues of the agents and the special modification of irritability which belongs to each part (§ 135). It is designed for the conservation of every part, and of the

* See Med. and Physiolog. Comm., vol. ii., p. 168, 169, 171–173.

† *Ibid.*, vol. i., p. 683–690, 699–712.

whole. Had not the lacteals and lymphatics been endowed in this wonderful manner, or were absorption a mere physical process, or capillary attraction, as it is called, all foreign substances would have free access to the internal parts of the organization, and organic beings would have had no continued existence. They would have perished as soon as created. Hence, are the vital properties so modified in all these millions of inlets into the labyrinth of organization, that they shall be not only vigilant sentinels, but recognize, at once, every one of the thousand offenders that may endeavor to steal its way into the *sanctum sanctorum* (§ 192).

277, *b*. Some of the most important laws in medicine are founded on the special modifications of irritability in different parts (§ 149, 150); and as it respects the lacteals and lymphatics, the principle not only contradicts the assumption of the operation of medicines by absorption, but confirms, in a beautiful manner, the laws of sympathy.

278. It is only when the lacteals and lymphatics become morbidly affected, or their irritability essentially modified by the morbific action of agents offensive to the organization, that those agents are at all admitted, and then only very sparingly. The principle is the same as when undigested food escapes the pyloric orifice in indigestion, or the red globules of blood gain admittance to the serous vessels in inflammation (§ 14, 74, 117, 137, 143, 155, 156, 169 *f*, 266, 303¼ *a*, 306, 310, 311, 325, 387, 399, 409 *f*, 422, 514 *h*, 524 *d*, 525, 526 *d*, 528 *c*, 638, 649 *d*, 764 *b*, 811, 847 *c*, 848, 902 *f*, 905).

279. If, therefore, foreign agents affect the vital properties in the foregoing manner, so also do they affect the condition of the other tissues of the part. This is the beginning of disease, which may now go on accumulating without any farther agency of the exciting cause; or, if the offending cause gain admission into the circulation, it may continue, *per se*, to exasperate disease. But, even in this case of the continued operation of morbific or remedial agents after their absorption, I have shown that solidism and vitalism can alone explain their effects (§ 819, &c.).

280. I have also shown that when morbific or remedial agents are taken into the circulation, the quantity is so small, their dilution by the blood and other fluids so great, and their elimination by the kidneys so rapid (from five to fifteen minutes), that little or nothing is likely to be contributed in this way to the morbific or remedial effects.

The rapidity with which agents that are not morbific, but useless to the system, are elaborated by the kidneys, is a proof, upon the principle of Design, that a provision exists for the exclusion of deleterious agents from the circulation. But, since they may, under special circumstances, pass the great sentinel (§ 278), the kidneys are provided as other guards to the general organism, to expel the offenders at once. Just so with the lungs. If offensive objects pass the larynx, all the muscles of respiration, through a beautiful system of Design, immediately set at work to get rid of the intruder. The intelligent reader will readily carry this principle to more recondite processes, as the institution of abscesses, and the curious steps that attend their progress from deep-seated parts toward the surface.

281. It may be also added, that I know of no critical attempt having been made to invalidate the facts and the reasoning set forth in my Essay on the Humoral Pathology, which has for its object the ex-

posure of that pathology and the defense of solidism and vitalism; and, although that work has been now five years before the public, I know not that I have omitted the investigation of one essential fact or experiment that has been alleged or instituted in behalf of humoralism. If such omission has occurred, let it be shown.

282. Many distinguished men have been led into the error of supposing that noxious substances are taken readily into the circulation because the skin is deeply tinged with yellow, in jaundice; or because the bones become red when madder is eaten; or the urine is colored by rhubarb, or manifests the odor of turpentine, of garlic, &c. But, let it be considered, that the inoffensive coloring matter of the bile is alone absorbed, as is also that of madder and rhubarb, &c.; while the thousandth part of a grain of spirits of turpentine, or of garlic, is enough to impart all the odor to the urine that has been ever observed to attend that product.

283. It may be also advantageously stated in this place, that the insoluble nature of many substances, such as the hydrargyri chloridum, the hydrargyri pilulæ, the hydrargyri unguentum, &c., positively contradict the statements which have been made as to their presence in the circulation, and enforce the importance of receiving with greater caution the experiments which are put forth to sustain an hypothesis, or which may apparently aim at notoriety (§ 264).

284. Although a very limited operation of morbific and remedial agents, through their absorption into the circulation, be not incompatible with solidism and vitalism (§ 277, 278, 283, 827 *f*), the usual interpretation of their effects, according to the doctrines of humoralism, would compel us to abandon the application of physiology to medicine, whether pathologically considered, or in respect to the operation of curative agents. The laws of disease would be totally unlike the laws of health; or, rather, disease would be without laws, and there would, therefore, be no general principles in medicine. Practice would be a blind empyricism. Diseases would be just as various and uncertain as every chemical change in the blood, and these changes, upon the ground of humoralism, would have no resemblances to each other.

285. The properties of life lie at the foundation of physiology. It is a knowledge of their character, and of the laws which they obey, that enables us to conform our habits, at all ages, in the best way for the maintenance of health. But, what is disease? It is a deviation from the state of health; and, therefore, if there be any consistency in nature, disease should consist primarily and essentially in modifications of those vital properties, which, in a different state, constitute the important conditions of health. In this way, therefore, medicine takes the rank of an intelligible and important science. Physiology is the ground-work throughout. Pathology becomes nothing more than physiology modified. And, coming to therapeutics, it is still physiology applied to the cure of diseases; or, in other words, the application of such agents to the morbid properties of life as shall aid their restoration to their natural physiological state. The whole is thus bound together. No new elements come into operation; but, throughout the whole series of changes, the same powers are in action and carry on all the processes. Nor are there any new laws introduced. The powers and actions being fundamentally the same.

so are the laws, of health and disease, as are those, also, by which diseased are converted to healthy conditions. But, the powers or properties of life being modified in disease, and again modified in other ways by the action of remedial agents, so are the laws, under which all these results happen, varied in a corresponding manner. The laws are only the conditions under which effects take place; and, as those effects have always a direct reference to the state of the vital properties, they must be fundamentally of the same nature under all the various conditions of life, since, also, the vital properties never lose their fundamental character.

286. When, therefore, I may speak of the laws of health and the laws of disease, I must not be understood as meaning something entirely different in the two cases. And yet, their modifications are always precise, and the results of each are always determined in one uniform manner. This is necessarily so, because the changes in the vital properties are always precise, and according to the nature of the influences by which the changes are effected (§ 149, 150).

287. In this sense, therefore (§ 286), the laws may be assumed to be, in each individual modification, of a specific nature.

288. Laws may be said to be general and specific; which, however, is only another mode of considering the foregoing principle (§ 285). Thus, it is a general law that the absorbents, whether in health or disease, do not take up foreign substances of a deleterious nature; but, it is a specific law, that when the irritability of the lacteals or lymphatics is modified in a certain way, they will admit a small proportion of the noxious agent by which the alteration is produced (§ 277, 278).

289. Those mechanical physiologists who have not, or will not have, just conceptions of the properties and actions of life, refer the process of absorption to capillary attraction, or that mechanical principle which determines the ascent of oil in the wick of a lamp (§ 277). The chemists belong to this class of reasoners; even such of them as allow the existence of a vital principle. Thus, for example, Liebig has it, that,

"A *cotton wick* inclosed in a *lamp*, which contains a liquid saturated with carbonic acid, acts exactly in the same manner as a living plant in the night. Water and carbonic acid are sucked up by capillary attraction, and both evaporate from the exterior part of the wick." Again, "All substances in solution in a soil are absorbed by the roots of plants exactly as a sponge imbibes a liquid, and all it contains, without selection."—LIEBIG'S *Organic Chemistry applied to Physiology and Agriculture.*

Now all this might be very good philosophy for a common agriculturist; but it evinces an unaccountable disregard of facts, and of the plainest suggestions of nature. And yet it is a common doctrine now-a-days; a part of the "new experimental philosophy." In the first place, however, it is not true that the roots of plants imbibe their nourishment "without selection." When plants are cultivated in glass vessels containing distilled water, their roots will even decompose the glass, and select its silica, or alkali, or take them both, and assimilate them to themselves, and in the absence of any known chemical affinities or influences. Absorption is nearly as exact in plants as in animals; and so is appropriation. Like animals, their absorbent system

is naturally repulsive of every thing that is offensive and not suitable to their economy. If poisons, when artificially applied, get admission, it is by inflicting a violence on the radicles of plants (§ 278). And what is thus prompted by reason, by analogy, by common experience, is fully confirmed by the chemists themselves, in those analyses of all parts of a plant, even the sap, which are designed as standards of the composition which shall serve for any particular part of any given species of plant, as well through all future time as at the hour when the analyses were made.

290. The simile of the "lamp-wick," and of the "sponge" (§ 289), show us how far astray our friends are from the path of truth. It is not alone the complex mechanism of the root which the absorbed materials traverse, but a labyrinth of highly organized and living tubes, passing through the whole trunk of the plant, till the materials finally reach the leaves. In those respiratory organs, the *pabulum vitæ* is farther subjected to the action of another complicated, unique, and living system of vessels. And what is the "wick of a lamp?" A mere bundle of dead, disorganized fibres, broken upon the card, and spun upon the wheel (§ 350½ *n*, *o*, 826 *c*).

291. But, the foregoing degrading doctrine of life (§ 289) is not peculiar to the chemists. Some reputedly profound physiologists apply it not only to plants, but to animals, and, like Liebig, identify the same vital and physical processes. One example, in a distinguished quarter, will suffice. Thus, Dr. Carpenter:

"It will be hereafter shown that the absorption of nutritious fluid is probably due to the *physical* power of endosmose. A continued absorption may be produced by a *physical contrivance which imitates the effects of vital action;* [!] *as in the wick of a lamp, which draws up oil to supply the combustion above, but will cease to do so when the demand no longer exists*" *!* (§ 64 *g*, 175 *c*).—CARPENTER'S *Comparative Physiology.*

The work, a standard one, from which the foregoing is quoted, abounds with analogous doctrines. They are, of course, fatal to physiology and to all medical science.

292. Immediately after the quotation from Liebig, in the preceding section, that author proceeds to reprobate physiologists for their exclusion of chemistry from organic life, and charitably regards it as a prejudice arising from our ignorance of the science (§ 350, *a*). This, however, is quite an untenable position; for, wherever medicine is cultivated, chemistry is justly made a fundamental part of education. It is, indeed, the knowledge which the soundest physiologists possess of chemical science, that enables them to institute the necessary contrasts, and which convinces them that chemistry, in its proper acceptation, has no connection with the processes of living beings. This, indeed, I have abundantly shown to be the real opinion of the chemists themselves (§ 350, &c.). Bold in assumption, inapt in illustration, and, at last, like Liebig, contradicting the whole by an acknowledgment that "*vitality, in its peculiar operations, makes use of a special apparatus for each function of an organ,*" and that "*in the living organism we are acquainted with* ONLY ONE CAUSE OF MOTION; *and this is the* SAME CAUSE *which determines the growth of living tissues, and gives them the power of resistance to external agencies.* IT IS THE VITAL FORCE."—LIEBIG (§ 350, nos. 26, 27, 28, 71–77, &c.).

293. Looking at other facts attending the process of absorption in plants, we shall find them all concurring with what I have already stated as to the dependence of this function upon vital actions; and, if vital here, we need not look for other proof of a similar law in animals. Thus, Van Marum demonstrated that absorbed fluids could rise only eight inches by capillary attraction. Hales, Walker, Mirbel, Chevreuil, and others, have shown that the sap moves with such velocity and force in plants, that it must be propelled by vital contractions and dilatations of the vessels. We have examples of this surprising rapidity of the circulation in grape-vines. Don and Barbieri affirm that they saw the movements of the vessels.

Again, the motion of sap is increased by light, heat, and other stimuli, which have no effect on capillary attraction. And this is the opinion even of Liebig, who says that "the FUNCTIONS of plants certainly proceed with greater intensity and rapidity in sunshine, than in the diffused light of day; but it merely ACCELERATES in a greater degree THE ACTION ALREADY EXISTING;" "an action," he says, "which *depends on the vital force alone.*"

It was shown by La Place, that, if the sap rose by capillary attraction, it should not, as it does, flow from the openings made in the vessels. But, again, the sap will not flow from the openings, if the plants be poisoned with prussic acid. The effect is the same as upon the circulation of the blood; and it would be equally absurd, in either case, to suppose that the poison acts upon any physical force. Astringents, and various other substances, applied to the openings, avert the flow of sap, which can only be done through the foregoing principles (§ 278–284).

294. Here is another fact, and which appears to be conclusive of the vital nature of absorption, and of the discrimination observed by the radicles of plants (§ 289, 291). It is, that the sap of the root is unlike any thing which it absorbs from the earth. All the substances are decompounded at the moment of entering the roots, just as the carbonic acid is by the leaves. Their elements are then also united according to the modes which prevail in organic compounds (§ 455, *c*).

295. Equally unfounded as the doctrine of capillary attraction are the supposed processes of endosmose and exdosmose. They are all alike predicated of experiments upon dead matter, and are then carried, by way of analogy, to the living organism, and in defiance of all the contradictory phenomena of life. Having entered extensively into a refutation of the hypothesis of endosmose and exdosmose, in the Medical and Physiological Commentaries, I shall not now resume the subject.

3. ASSIMILATION.

296. By the function of assimilation the substances taken into the body are converted into the homogeneous blood, and identified in composition and vital properties with all parts of the body. It is therefore especially concerned in the process of growth, and in supplying the waste which is constantly in progress. It is the function, therefore, by which the properties of life are communicated to dead matter.

297. All dead matter, before its reception into the body, is subject to the forces of chemistry. The operation of these forces is arrested in the alimentary canal of animals, and in the absorbing vessels of plants.

298. The nutriment of vegetables consists always of inorganic substances, or is reduced to the condition of inorganic matter before its appropriation. The food of animals is always organic. The former exists in an elementary or in a state of binary combination, the latter of ternary, quaternary, &c. It is the work of vegetable assimilation to overthrow the chemical combinations, and to unite the elements in those very different modes which constitute organic compounds. This is the most remarkable and comprehensive System of Design of which we have any knowledge.

299. Assimilation, therefore, devolves especially upon the properties vivification and vital affinity (§ 214, 218); though it be certainly true that all the organic powers and functions are necessary to each other, and concur together in producing every result. But, in every result there are some more interested than others.

300. Animals, being incapable of organizing inorganic substances, are dependent upon the vegetable kingdom as their ultimate source of supply (§ 13, 14). Such, indeed, is the final cause of vegetable life. But the food of animals must be dead before it can begin to undergo the action of the vital properties in another being. The gastric juice, for instance, has no effect upon any living substance.

301. No organic compound ever undergoes chemical decomposition, or any approximation toward such decomposition, to fit it for the purposes of animal life. On the contrary, every such tendency places the appropriate nutriment of animals, more or less, beyond their assimilating endowments. It is the province of animal life, and of all its provisions for assimilation, not to carry back toward their inorganic condition the peculiar compounds generated by the vegetable kingdom for the foreordained uses of the animal, but to carry them forward to yet higher degrees of life and organization. This is one of the most fundamental laws of nature, and is conclusive against all the chemical speculations with which physiology has been so unhappily visited.

302, *a*. The assimilating organs in vegetables are more simple than in animals, and the complexity increases in animals according to their rank in the scale of life. It would appear, therefore, that organization bears a ratio more or less proportionate to the endowment of organic compounds with the properties of life (§ 301, 409).

302, *b*. The process of converting inorganic into organic compounds begins in two orders of vessels, one of which are the radical absorbents of plants, the other analogous vessels in the leaves.

The matter absorbed by the roots ascends through the stem to the leaves, where, by the operation of a series of vessels, variously modified in different species, it is converted, along with that absorbed by the leaves, into a juice, which, like the blood, is thus fitted for the purposes of nutrition. This juice then descends through other vessels, to be appropriated to all parts, and to form the source of all the various products of vegetable organization.

303, *a*. We come, therefore, to a conclusion as remarkable as it is comprehensive, that the atmosphere is not only essential to plants and animals in its usual acceptation, but that it supplies the great means of nutriment to both organic kingdoms; directly to the vegetable, and indirectly to the animal department (§ 298–300). The assumption as put forth in Liebig's *Animal Chemistry*, that "all matters which serve

as food to living organisms are compounds of two or more elements, which are kept together by certain chemical forces," must be abandoned, and we must look to the atmosphere and what it contains for the four great elements which compose organic beings. The oxygen and the nitrogen of the air, the oxygen and the hydrogen of the vapor which the air contains, and the carbon of the carbonic acid, are as much at this day the great source of nutriment to plants, as before the "mist" went up from the seas, or animals yielded ammonia. Oxygen and nitrogen, therefore, as it respects atmospheric air, are appropriated by plants in their elementary condition. Upon organic compounds thus formed is animal existence, in the main, dependent. Ammonia certainly contributes to the nourishment of plants. But this is an incidental means, at least if there be any truth in Moses. And that his Record is true, is plain enough upon the principle of Design; since it is impossible that Providence should have created the animal kingdom, which yields the ammonia, before he brought forth that kingdom upon which animals depend for their existence.

303, *b*. As it respects *absorption*, the leaves and the roots of plants appear to have a common office, though the former are designed especially for assimilation. The carbonic acid, and the oxygen and the nitrogen of the air, are precipitated along with the vapor, and thus reach the organs which are principally devoted to absorption. In no other way can we primarily reach the materials of all organic beings. Before their absorption can have begun, the whole essential elements must have been embraced originally in the atmosphere, and in the simple conditions which I have stated. Nor is it a difficult process to follow out that circuit of causes and effects in which revolves the economy of nature in making the waste of organic beings during their own existence a subsidiary supply of nourishment to themselves, or to others of their own day, or to generations in the womb of time; or, when consigned "to the dust," how their elements, from one generation to another, form an endless round of materials for reproduction and growth, either in the form of gases and vapor diffused in the air, or as imbodied with the earth.

303, *c*. Although it be the special object of the radical fibres to carry on the function of absorption, this office is more or less performed by the leaves of plants, but in various degrees, according to the nature of the species. In arid climates, the leaves have this function strongly pronounced; and many plants, like the *sempervirens*, will grow as well when suspended by a string, as when connected by their roots with the soil.

303, *d*. The leaves of plants absorb carbonic acid mostly during the day, decompound it, as do the roots those binary compounds taken in from the soil, and otherwise prepare it as an important source of nourishment. Light is necessary to this function of the leaves, or, at least, to its proper performance; and it is remarkable that while in progress, it is attended by an evolution of oxygen gas, but that during its suspension, as in the night, oxygen gas is absorbed by the leaves and carbonic acid given out. This, however, is said by distinguished physiologists to be only partially true as it respects these processes at night; some affirming that they have witnessed the same results at night as during the day. The chemists have an interest in making the light the agent of decomposition. But the light acts only as a vital

stimulus to the leaves, by which their organic properties are rendered capable of overthrowing that most refractory compound, carbonic acid (§ 188½ *d*, 350, nos. 46, 47, 48, 49, 50, 51, 52, 53, 54).

303, *e*. The leaves of plants being the great organs of assimilation, and light the vital stimulus by which the function is maintained (§ 188½, *d*), it appears from what has been now said that *light* holds the first rank among the requisites of life. It was therefore brought into existence before the creation of the vegetable kingdom; and being thus indispensable to all living beings, we see the fallacy of a common tenet in theoretical geology, that the most thrifty period of vegetation was through a great cycle of total darkness, and an atmosphere of carbonic acid (§ 74).

303¼, *a*. One of the most interesting facts in vegetable physiology, is the immediate necessity of plants to animal life during their very growth; their final cause, in this respect, being the abstraction of carbonic acid from the atmosphere, and the renewal of its oxygen. Animals, too, as we have seen, incidentally contribute carbon to the vegetable kingdom, in the form of carbonic acid, and nitrogen in the form of ammonia. There is this remarkable subserviency of the organic kingdoms to each other, though there be not a reciprocal dependence. Vegetables, indeed, preceded animals, and are, therefore, essentially independent, while animals derive all they possess from vegetable creation (§ 303, *a*). Plants are the producers, animals the consumers. The former directly, and the latter indirectly, live upon the air and what it contains. The plant dies and becomes food for the animal; but it seems scarcely less important in its living state to the exigencies of animal life. And so the animal, living and dead, yields back its all to the atmosphere; and thus are the inorganic, and the two departments of the organic, kingdoms united.

303¼, *b*. But, we have seen, as I originally indicated in the Essay on the *Philosophy of Vitality*, that the supply of ammonia to the atmosphere is only a contingent result of the creation of animals, and therefore not indispensable to vegetation (§ 156 *b*, 303 *a*). Liebig, however, reverses the order of Creation, and affirms that

"We have not the slightest reason for believing that the nitrogen of the atmosphere takes part in the process of assimilation of plants and animals." "These facts are not sufficient to establish the opinion that it is ammonia which affords all vegetables, without exception, the nitrogen which enters into the composition of their constituent substances. Considerations of another kind, however, *give to this opinion a degree of certainty which completely excludes all other views of the matter*."—LIEBIG'S *Organic Chemistry*, &c., p. 70, 71.

303¼, *c*. The same mistake has arisen with the chemists as to the reciprocal dependence of animals and plants, in regard to the excretion of carbon by one and oxygen by the other. However true it may be that animals are dependent on plants for oxygen gas, it is certainly an assumption that the vegetable kingdom is alike dependent on the animal for its carbonaceous element. If the primary creation of plants be admitted, that is sufficient; and to those who reject the Mosaic Record, and the concurring testimony of geologists, I may adduce the admitted fact that vegetables are the ultimate source of supply to all animals. The former, therefore, are essentially independent, the latter dependent; while this universal fact corroborates, also,

the original account of the primary creation of the vegetable kingdom (§ 303¼).

As to the relations of the living plant to organic life, it is computed by Saussure, and allowed by others, that the atmosphere contains about $\frac{1}{1000}$th part of its weight of carbonic acid. The atmosphere must be also losing, through the processes of respiration, combustion, &c., a proportion of its oxygen. It is estimated, also, that the present number of human beings would, alone, double the existing quantity of carbonic acid in the air in 1000 years; and, in 303,000 years would exhaust its oxygen. It is also found that atmospheric air of the present day does not contain less oxygen than that which is found in jars buried for 1800 years in the ruins of Pompeii.

From all this it is inferable that there is a universal cause in operation, by which the carbonic acid of the air is consumed, and oxygen supplied; and, from the various well-known, and indispensable uses of the vegetable kingdom to the animal, *which declare its creation for the benefit of the latter*, and, therefore, its antecedent or simultaneous creation, we should naturally be prompted, by analogy, to look to this subordinate provision as the universal source through which the great purposes of respiration are maintained unimpaired. Chemistry has here elegantly illustrated this great element in the final causes of the vegetable kingdom, and the contingent aid which it derives from the animal; while it enlarges our view of the vast conceptions of Unity of Design.

303½. It is also worth our while to observe of these important laws, as we go along, how they are perverted by the ignorant in physiology, and how incapable the chemist is constantly proving himself of "pursuing his reasoning," as said of him by Hunter, "even beyond the simple experiment itself."

Vegetables, as we have seen, are composed mainly of carbon, oxygen, hydrogen, and nitrogen (§ 37, 303). The carbonic acid of the air (as well as of the soil) is absorbed by plants, and appropriated to their nourishment and growth. This gaseous substance, therefore, is decomposed by vegetable organization, the carbon vivified and appropriated, and a part of the oxygen thrown off to replenish the atmosphere. It is incorrectly said, however, by Liebig, that "the atmosphere must receive by this process a volume of oxygen for every volume of carbonic acid which has been decomposed." Oxygen gas is a large and important element of vegetable substances, and a proportion, therefore, of the oxygen of the carbonic acid is evidently retained, and combined under a new form along with the carbon and other elements. In making all plants yield the whole of the oxygen of the carbonic acid to the air, Liebig sacrificed vegetable physiology to one of his favorite chemical assumptions. His hypothesis, also, as to the dependence of absorption upon the mechanical process of capillary attraction, has led him to overlook the fact that the water which is absorbed by plants is actually decompounded, and its elements combined with others according to the laws which determine organic compounds. It is water, indeed, which yields, far more than ammonia, the hydrogen which abounds in plants (§ 303, *b*). Water, therefore, being composed of oxygen and hydrogen, furnishes a source of the supply of that oxygen which goes to the increase of vegetables; and, for aught that can be said to the contrary, it may form a part of what is evolved into the air.

There are also other sources from whence vegetables derive their oxygen, namely, from some mineral compounds appertaining to the earth, and directly, by means of the leaves, from the air itself (§ 303). The latter process goes on, mostly, in the night, and the decomposition of the carbonic acid is then, also, more or less arrested; or, as is generally supposed, a certain proportion is generated and emitted by plants; and that those actions are analogous, to a certain extent, to the respiration of animals, having for their object, in part, the separation of carbon from some of the vegetable constituents.

303⅔. Here, again, let us pause to observe the windings of the chemist and his conflicts with nature.

"At night," says Liebig, "A TRUE CHEMICAL PROCESS COMMENCES, in consequence of the action of the oxygen of the air upon the substances composing the leaves, blossoms, and fruit. This process is not at all connected with the life of the vegetable organism, because it goes on in the DEAD plant EXACTLY as in a LIVING one"!

Here, in the first place, is an important fallacy in the premises from which the induction is made; since the processes have not the least analogy in the living and dead plant. In the former, the oxygen is taken into the organization, and goes to form organic compounds. In the dead plant, it is an agent of chemical decomposition, by which the organic compounds are destroyed, and the structure broken up.

Now we shall always find that authors who reason in the foregoing manner perpetually contradict themselves. In the case before us, a contradiction necessarily arises from the fundamental differences between the processes of organic and inorganic beings, and the laws by which they are governed. A little farther on from the quotation I have just made, Liebig affirms that "*the laws of life cannot be investigated in an organized being which is diseased or dying.*" Here, then, is a contradictory opinion, which inculcates as great an error in physiology as that of identifying the effects of oxygen on "living beings" and on such as are actually dead. Here is an absolute denial of any analogies between the laws which govern living "diseased beings" and the "laws of life." But, this declaration of the chemist, devoid of truth as it is, is universally applicable where he would be least disposed to see it operate. Such an application, too, is an irresistible *sequitur;* since, if "*the laws of life cannot be investigated in an organized being which is diseased* or dying," it certainly follows that the laws which relate to dead, or inorganic beings, and the forces upon which those laws depend, can have no agency in living beings.

Such, however, is the material which is now-a-days denominated "experimental philosophy," and "the progress of medical science." And, if the reader will now turn to the parallel columns (§ 350), he will see yet other contradictions directly relative to the foregoing quotation.

But, it may, perhaps, be well enough, before dismissing this subject, to say, that, although "the laws of life cannot be investigated in an organized being which is dying," the laws which govern diseased actions and their results are only slightly modified "laws of life," and often reflect great light upon their strictly healthy condition. We are, or should be, constantly reasoning in this manner in all cases of disease; and it is only by comparisons of the modifications, which constitute disease, with the natural conditions of life, that we can have

any just knowledge of diseases. In proportion, however, as the individual approximates a state of death, all this reasoning fails; and, when actually dead, no such comparisons can be instituted. Here, then, it is that the foregoing admission of the chemist applies with all the force of truth.

304. The greater complexity of the organs of assimilation in animal life gives rise to a variety of subordinate functions in animals not found in plants; such, for example, as digestion by the gastric juice, saliva, bile, &c.; then a farther advancement of the process in the lacteals, in the blood-vessels, in the lungs, &c. Some of these subordinate functions, however, have their analogies in plants; such as the action of the sap-vessels upon the circulating fluid, the imbibition and exhalation of gaseous substances by the leaves, &c. But, in all the cases, the extreme vessels which perform the office of nutrition are the main instruments of organic life. All the functions which are carried on by compound structures are subsidiary only to that of the nutritive vessels (§ 171).

305. The organs of assimilation in animals are more or less complex, according to the nature of the food. Probably every animal has a stomach, or some analogous organ, and a mouth, and anus, which would form, as supposed by Aristotle, a fundamental distinction between plants and animals (§ 11). The analogies which are supplied by the higher orders of animals would prompt this conclusion in respect to the most inferior.

306. In vertebrated animals, the stomach is generally an expanded portion only of the intestinal canal. In fishes, the intestine is commonly short; but this is often compensated by folds in the mucous membrane. In birds, there is a complexity of the alimentary organs which does not exist in fishes, amphibia, or reptiles. In mammalia, the digestive organization is still different; and here it is more remarkably various according to the nature of the food, and as the necessity of supplies may be felt at short or at longer intervals. The more, also, the phenomena of animal life are multiplied, the greater is the development of the digestive system (§ 131, 251, 409 *l*). Its complex nature has an intimate relation to the qualities of the food, and these relations have an affinity with that principle of instinct which directs animals in the selection of food. The more dense and tough the food, and the more removed from the nature of the body which it is destined to nourish, the more complex are the organs of digestion. And so, on the contrary, the softer the food, and the more it is like the animal in its composition, the more simple are the assimilating organs. Animals, therefore, which live on hay, have these organs much more complex than such as are nourished by animal food; especially that part of the organization which is destined to make the first and greatest change.

307. The principal agent in the assimilating process, in animals, is the gastric juice; a vital organic fluid, which is secreted by the internal coat of the stomach (§ 135 *a*, 316, 419, 827 *b*). This secretion is especially promoted by the stimulus of food, which is dissolved and altered in its elementary constitution by the vital influences of the juice. This is the first and greatest step in the process of assimilation. It is here that dead matter receives its first impressions from the properties vivification and vital affinity (§ 216, 218). The chemists tell us

that the process is a chemical one; and that, notwithstanding the various, and unique, and astonishing devices of nature for the elaboration of the gastric juice, they would stultify physiologists with the pretense that many different processes of the laboratory will generate a gastric juice with all the unique properties that appertain to the fluid as elaborated from the blood by the various modifications of organization which were instituted by Almighty Power for these specific objects. And having been thus regardless of the most sublime and profound institutions of that Power, they proceed to assume that the product of these artificial compounds, in their action upon food, is the homogeneous chyme of living nature, and which is apparently the same in all animals, whatever the kind or the variety of food. But the chemist is met at the very threshold by the fact, that there is nothing in organic nature itself that can elaborate that fluid from the blood but that particular part of the great system of mucous membranes which forms a component part of the stomach (§ 135, *a*).

308. The plainest analogy leads us, therefore, to the conclusion that all animals possess a stomach; while the universality of the gastric juice shows its fundamental importance in the animal economy.

309. In most animals that consume food of a solid nature, there are preparatory organs which assist mechanically, by dividing the food. The construction of these organs of mastication, both as to their osseous and muscular parts, has a strict reference to the kind of food upon which the animal is destined to subsist. Animals of prey are furnished with organs for the destruction of life and organization; since no substance which possesses life can undergo digestion, and all solids must be divided to admit of a free access of the gastric juice and saliva.

310. The organs of mastication are more various than any other parts; yet so uniform in each species, so allied among numerous species, that naturalists have taken these characters not only as significant of the species, but as the foundation of a systematic distribution of the species into genera, and of genera into orders.

311. Where the usual organs of mastication are deficient in animals, the species is often supplied with means in the stomach itself for reducing the aliment to a soft substance, so that it may be penetrated by the gastric juice. The stomach of the armadillo, which subsists on insects, and of the granivorous birds, is endowed with a powerful muscle for crushing, or grinding the food. The stomachs of other animals are armed with bony or horny parts, as in many insects.

312. The food is moved about in the stomach by the muscular action of the organ; but so peculiar and exquisite is the modification of irritability of the pyloric orifice, the food is not permitted to pass this outlet till it is converted into chyme (§ 278). Much of the aqueous portion, however, is early and rapidly absorbed by the stomach.

313. When, however, as we have seen, the irritability of the pylorus is artificially modified, as in disease, it will often allow undigested food to pass, more or less readily, into the duodenum (§ 278). But it is more remarkable that it will suffer many hard, indigestible substances to escape, while it detains such as are most congenial to its nature. The passage of indigestible substances is effected gradually by repeatedly presenting themselves at the pylorus, and thus so habituating the irritability of that orifice to their own irritant effects, but not to those of digestible food, that they are allowed to pass, while

the latter is detained; the stomach thus electing what is most congenial to its nature and to the wants of life (§ 188, &c., 539 *a*, 543 *a*, 551).

314. The saliva, bile, and pancreatic juice are auxiliary to the gastric juice, though how far is considered problematical. The liver is found, under a great variety of forms, in all animals whose structure can be made the subject of ocular demonstration, and it is known to generate bile in all instances. The pancreas and salivary glands occur in all the mammifera, birds, and reptiles, and in many fishes, mollusca, and insects.

From the great universality, therefore, of the foregoing organs, it cannot be doubted, independently of the more direct facts, that the fluids which they secrete have an important vital agency in the process of assimilation.

315. Animals which live on vegetables have larger salivary glands than such as feed on animal substances; and, since vegetables require greater assimilating means than animal food, it is a just inference from final causes that the saliva answers a far more important object than, as is commonly imputed to it, of moistening the food and facilitating its passage to the stomach. On the other hand, however, it has been with still less reason imagined by others that it contributes more than the gastric juice to the conversion of food into chyme. But here, as on all speculative questions, some distinguished chemists refer the agency of the saliva in the process of digestion to the atmospheric air it conveys to the stomach, while others of equal renown attribute this high office to its own specific virtues.

316. The bile and pancreatic juice mingle with the chyme in the upper part of the duodenum, where it is probable that the latter fluid contributes an assimilating influence analogous to that of the saliva; while the disappearance of some of the components of the bile, and other relative facts, show a direct connection of this fluid with the process of assimilation. The bile also separates the excrementitious from the nutritious part of the chyme; the former portion occupying the centre of the canal, and the latter the parietes (417, *b*).

Connected with these important uses of the bile, is its well-known function of maintaining peristaltic action. Such, therefore, being its great final causes, we may safely reject the hypothesis of the mechanical theorists, that the liver, like the lungs, is designed to depurate the blood. The injury consequent on the failure of the liver, by experiment or otherwise, to perform its function, no more proves its supposed depurating office than a like contingency befalling the stomach would place that organ in the same category.

317. The intestinal tube, like the roots of plants, is supplied with absorbing vessels, which are called *lacteals* in animals of complex organization. The nutritive part of the chyme is taken up by these vessels, where it undergoes a farther assimilation, and receives the name of *chyle.*

Nothing is absorbed by the lacteals which is offensive to their exquisitely modified irritability, excepting under the circumstances already set forth (§ 278).

318. In the higher animals, the chyle is transmitted by the lacteals to the thoracic duct, and by this vessel to the left subclavian vein, where it mingles with the general mass of blood. Thence it passes to the right cavities of the heart to be sent to the lungs, where it re-

ceives another important impress of vivification, parts, for the first time, with a portion of its carbonaceous matter, and undergoes a development of its coloring principle. From the lungs, it passes with the old blood, with which it is now fully incorporated, to the left cavities of the heart, to be transmitted to all parts of the body to undergo the last act of assimilation.

319. Assimilation advances progressively from the first conversion of food into chyme, till the nutritive matter becomes vitally united with the solid parts. At each step of the process, in the stomach, in the duodenum, through the lacteals, in the lungs, and at its final destination, the degree and kind of assimilation is forever the same, at each of its stages, in every species of organic beings; thus denoting specific powers and laws by which all this unvarying exactness is maintained (§ 42).

Assimilation is more simple in animals low in the scale of organization; but close analogies prevail throughout.

320. The chyle is said to exhibit globules under the microscope, which is probably true. Others affirm that they have seen them in the chyme; but Müller thinks that impossible, as the lacteals, according to him, have no open orifices, and, therefore, the globules could not be admitted through the "invisible pores" of the closed lacteals. These vessels, however, have open terminations in the villi of the intestines (§ 275).

These questions as to the existence and shape of the globules of blood, chyle, milk, &c., are of no farther practical importance than as they lead to much waste of time, and encumber medicine with speculation and false doctrine; while the instrument, through the aid of which the imagination is thus sent upon its airy flight, is also the imbodyment of a thousand falsehoods in the path of truth (§ 131).

321. Since, however, no one doubts that the nutritive part of the chyme undergoes a very positive change in the lacteals (§ 320), and a higher degree of assimilation, the proof is the same here, as in absorption by plants, that the fluid is not taken up and carried forward by capillary attraction (§ 289–291).

322. Looking back upon the variety of parts which are concerned in the work of assimilation; their exact adaptation to each other; their peculiarities in different species of animals according to the nature of their food—varying, indeed, more or less in every species, yet always alike in all individuals of the same species; the universality of four specific digestive fluids, and each of these analogous in all animals, notwithstanding the variety in the structure of the secreting organs, yet only generated, respectively, by one special part, their production in unusual quantities, especially of the gastric juice, to meet the exigencies of digestion; the apparently exact similarity in the composition of the chyme of all animals, whatever the nature and the variety of the food; it appears to be one of the highest absurdities to suppose that all this complexity of parts, all this magnificence and variety in Design, should be merely intended to subserve a chemical reduction of food in the stomach, especially, too, as all that is known of chemistry is in conflict with every part of this stupendous whole. And when we pursue the other steps through which the great end of digestion is attained, and steadily regard each individual part forever giving rise to certain unvarying results, each part in its anatomical

and vital relations to all the rest, the necessity of every part to every step in the process of assimilation, the necessity of the whole to every secreted solid and fluid, the derivation of the whole unique and forever exact variety (millions upon millions, § 41–46) from four elements mainly, from one homogeneous fluid which embraces yet fourteen other elements, the necessary co-operation of many of the secreted fluids toward their own formation individually, and toward every formation in the complex animal—when, I say, we duly consider this labyrinth of complexities, moving on in one unvarying round of harmonious action and results, moved by a power within which has no known analogy in the world where chemical results obtain, we may reconcile unbelief in all this Design with a yet higher order of infidelity, but certainly not with the ordinary promptings of reason, or with the plainest rules of evidence (§ 638).

But, let us analyze, in another section, the great plan of nature for the maintenance of organic life in animals.

323. Let us analyze, after the manner of Cuvier, the constitution of animals in respect to the subserviency of the various parts of the fabric to the single function of digestion, and according to the nature of each species of animal; and when we shall have reflected upon the principles which determine the coincidences, and see that no one of them can be explained by any of the forces and laws of the inorganic world, let us cast from us, as unworthy a thoughtful mind, the supposition that the final act, or that of digestion, is a chemical process; and let us also apply the same induction to every other process of living beings.

"Every organized being," says Cuvier, "forms a whole, a unique, and perfect system, the parts of which mutually correspond, and concur in the same definite action by a reciprocal reaction. None of those parts can change without the whole changing; and, consequently, each of them, separately considered, points out and marks all the others. Thus, if the *intestines* of an animal are so organized as only to digest flesh, and that fresh, it follows that the jaws of the animal must be constructed to devour prey, its claws to seize and tear it, its teeth to eat and divide it, the whole structure of the organs of motion such as to pursue and catch it, its perceptive organs to discern it at a distance. Nature must have even placed in its brain the necessary instinct to know how to conceal itself and lay snares for its victims. That the jaw may be enabled to seize, it must have a certain-shaped prominence for the articulation, a certain relation between the position of the resisting power and that of the strength employed with the fulcrum; a certain volume in the temporal muscle, requiring an equivalent extent in the hollow which receives it, and a certain convexity of the zygomatic arch under which it passes. This zygomatic arch must also possess a certain strength to give strength to the masseter muscle. That an animal may carry off its prey, a certain strength is requisite in the muscles which raise the head; whence results a determinate formation in the vertebræ and muscles attached, and in the occiput where the muscles are inserted. That the teeth may cut the flesh, they must be sharp, and they must be so more or less according as they will have more or less exclusively flesh to cut. Their roots should be more or less solid, as they have more and larger bones to break. All these circumstances will, in like manner, influence the de-

velopment of all those parts which serve to move the jaw. That the claws may seize the prey, they must have a certain mobility in the talons, a certain strength in the nails; whence will result determinate formations in all the claws, and the necessary distribution of muscles and tendons. It will be necessary that the forearm have a certain facility in turning, whence, again, will result certain determinate formations of the bones which compose it. But, the bone of the forearm, articulating in the shoulder-joint, cannot change its structure without this also changes."

Again, observe what may be inferred from some other given part, as from the shape of the bones: "The formation of the teeth bespeaks that of the jaw; that of the scapula that of the claws; just as the equation of a curve involves all its properties. So the claw, the scapula, the articulation of the jaw, the thigh-bone, and all the other bones separately considered, require the *certain* tooth, or the tooth requires them, reciprocally; and, taking any one of them, isolated from the skeleton of an unknown animal, he who possesses a knowledge of the laws of organic economy, could expound every other part of the animal. Take the *hoof*, for example. We see, very plainly, that hoofed animals must all be herbivorous, since they have no means of seizing upon prey. We see, also, that having no other use for their fore-feet than to support their bodies, they have no occasion for a powerfully-framed shoulder; whence we infer, what is the case, the absence of the clavicle and acromion, and the straightness of the scapula. Not having any occasion to turn their fore-legs, their radius will be solidly united to the ulna, or, at least, articulated by a hinge-joint, and not by ball and socket, with the humerus. Their herbivorous diet will require teeth with a broad surface to crush seeds and herbs. This breadth must be irregular, and for this reason the enamel parts must alternate with the osseous parts. This sort of surface compelling horizontal motion for grinding the food to pieces, the articulation of the jaw cannot form a hinge so close as in carnivorous animals. It must be flattened, and correspond with the facing of the temporal bones. The temporal cavity, which will only contain a very small muscle, will be small and shallow," &c. (§ 169, *f*).

324. An intestine, claw, tooth, hoof, or other bone, therefore, of an unknown animal being given, we may construct a skeleton that shall be nearly true to nature in all its parts. We may then proceed to cover it with muscles; and, lastly, we can tell from that tusk, or claw, or hoof, or other bone, what was the structure of the digestive apparatus, and to what kind of food the gastric juice was specifically adapted, and what were the peculiar instinct and habits of the animal,—so special is the adaptation of all other parts of the organization, both in animal and organic life, and all the habits and instincts of animals, to the peculiarities of the digestive organs in every species (§ 18).

325. Now the whole of the foregoing mutual concurrence of all parts of the body, the adaptation of each part to the others in structure and use, being directly designed to subserve the purposes of digestion, and since it cannot be seriously entertained that any physical or chemical force is concerned in such a labyrinth of harmonious structure and actions, and so distinguished throughout by a multitude of the most consummate Designs, and all conspiring to one common end, it is manifestly absurd to imagine that *digestion, the final cause of the*

whole, is carried on by agencies which have no connection with the various subordinate means (§ 14, 74, 80, 117, 129 *i*, 133–137, 143, 155, 156, 169 *f*, 266, 303¼ *a*, 306, 318, 336, 387, 399, 422, 514 *h*, 524 *d*, 525, 526 *d*, 528 *c*, 638, 649 *d*, 733 *b*, 764 *b*, 811, 847 *c*, 848, 902 *f*, 905).

326. What we have now seen of fundamental Design in the construction and subservience of all parts to the function of assimilation, and of the exact concurrence of the whole toward the incipient step, may well prepare the mind to realize the same Design throughout the whole system of organic processes, the same exact foundation in anatomical structure, and in vital properties, the same precise and everlasting laws (§ 169, *f*). Do we look again, therefore, at the stupendous fabric upon which, and its special vital endowments, the laws of sympathy depend? Astonishment abates, and unbelief yields as well to the force of analogy as to direct demonstration.

327. The philosophy of assimilation applied pathologically, and in conformity with the doctrines of solidism, is the following: The function of assimilation, being performed by the organic properties through their media of action, there will be a corresponding change in the elementary combination of the new compounds which are added to the parts affected, and the same morbid condition of the vital properties will be imparted to the new compounds.

328. If the stomach be diseased, then the nature of the gastric juice will be altered according to the manner in which the properties of the stomach may be affected. If, also, we allow, in this case, that the chyme will have a corresponding variation, and that this will in itself affect the whole character of the circulating mass of blood, so that the new elementary combinations, those of the solids and secreted fluids, will be more or less modified in all parts, we shall in no respect compromit the consistency of nature, or the fundamental principles of physiology (§ 44, 52, 78, 153–155, 218–220). However such admission may look like humoralism, it has no affinity with it. The whole process resolves itself into a primary disease of the solids; and the modified condition of the blood, which I am now supposing, does not derange the vital properties and actions of the system (§ 156 *b*, 845, &c.). But when chylification is affected by diseased states of the stomach, sympathetic influences are then so exerted by that organ upon other parts, that their vital states do actually sustain a change, and often a far greater one, from that sympathetic cause. This more general modified condition of the solids contributes still farther to modify the new combinations, and to give rise to what are called vitiated secretions. The most striking examples are seen, of course, when digestion fails altogether, and the solids become universally affected by disease, as in fever (§ 143 *c*, 148, 657 *b*, 776, &c.).

329. If the heart and vascular system at large feel, mainly, the influence of gastric or some other local disease, the blood is always more or less affected in its composition, and assimilation is otherwise variously modified in all other parts, not only in consequence of the change in the blood, but of the affection of all the organs and fluids which are concerned in assimilation. Nothing affects the composition of the blood so rapidly as disturbances of the vital conditions of the heart and blood-vessels; or, perhaps, I should rather say of the extreme capillary blood-vessels. Nothing can prove more distinctly the truth of solidism and the fallacies of humoralism; especially those

more instantaneous changes which are effected in the entire circulating mass of blood by abstracting only an ounce of it from the arm (§ 845, &c.).

330. Now, suppose, instead of treating disease upon some broad principles, we were to undertake the specific object of the humoralists in any of the foregoing cases (§ 327–329); that is to say, the restoration of the blood in its composition and nature. The humoral pathologist would attempt its *direct* medication, in the vain hope that his drugs can produce, by their direct action upon the fluid, that natural combination of its elements, and that natural state of its vital properties, for doing which Nature has provided the whole system of the great vital organs, and many living secretions (§ 845, &c.). Since, therefore, the humoralist has not a physiological principle for his government, he has departed wholly from nature. The duty of cure thus devolves upon the solidist, who proceeds to restore assimilation by re-establishing the natural condition of the various tissues and organs whose functions had become deranged and had been the cause of the altered condition of the blood; and this is effected according to the manner set forth in my chapter on the *modus operandi* of remedial agents. There, too, you shall find, as well as in my disquisitions upon the philosophy of solidism, that the living solids are the only agents which can possibly effect any salutary changes in the *pabulum vitæ*, and, therefore, that when the former are diseased along with the latter, they must take the initiating step both in the morbid and healthy processes. Just in proportion, therefore, as the solidist improves the condition of the diseased organs, assimilation will approximate its natural state, and the blood be regenerated according to established physiological laws.

331. The condition, therefore, of the blood and of the products elaborated from it, in all cases of disease, should be regarded only as more or less significant of the morbid changes which may affect the solid parts.

332. Having now gone over the general philosophy relative to assimilation, I shall proceed to consider its principal element, or what is denominated

THE PHYSIOLOGY OF DIGESTION.

In my investigation of this subject I shall enter rather extensively upon the ground of *Organic Chemistry*, in all its applications to the science of medicine; since it is here, especially, as said in the Commentaries, that chemistry has reared its batteries, and from whence it sends forth its artillery into the various dominions of organic life. A contrast will be instituted under the general designations of PHYSIOLOGY and ORGANIC CHEMISTRY, in their relation to healthy and morbid processes.

333. The doctrines of life, as hitherto expounded, should be applicable to all the problems in organic beings which may seem to a superficial observer to fall under the laws of chemistry, or of physics. Such problems are especially presented by digestion, respiration, and the production of organic heat; and these are the main intrenchments of chemistry. If the philosophy, therefore, which I have thus far propounded lie at the foundation of the foregoing results, it is probable that chemistry must be abortive in facts, and wild in conclusions; and

the more so as it advances to the greater obscurities in physiology, pathology, and therapeutics. Such are the realities; and their exposure is the overthrow and the perpetual doom of organic chemistry.

334. Human physiology has been greatly vitiated, in recent times, by experiments upon animals, and conducted under the most unnatural circumstances. They have been extensively made, in a physiological aspect, without any view to the differences in organization and vital constitution between animals and man, and often with a reference to more functions than belong to any organic being. When prompted by pathological and therapeutical considerations, the experiments have been liable not only to the foregoing objections, but to the greater one of assuming that there is no difference in the susceptibility of organs to the action of natural, morbific, and remedial agents in the varying states of health and disease (§ 149, 150, 240). These experimental fallacies, and the vast errors to which they have led and are still leading, I have considered extensively in my Essay on the Humoral Pathology.

In a physiological sense, the greatest evil attending the foregoing experiments consists in neglecting the fact that the constitution of man is different from that of animals, when applying the results of such otherwise unnatural experiments to explain the vital laws which govern the functions of the human species.

The disparity increases between the natural laws and results of the human and those of vegetable organization, and others, again, of chemical affinities, just in the ratio of the difference between the varieties of organization and vital constitution, and the attributes of the inorganic kingdom.

335. What, then, shall be said of those experiments which are conducted in the laboratory of the chemist to determine the physiology of the highest function of life, but in which organization takes no part, and the whole process is carried on by artificial "mixtures" and chemical reagents? This is now the almost universal philosophy, and therefore demands an investigation which shall lead either to its confirmation or to its overthrow.

336. It is in the stomach that vitality is exemplified in its most impressive and astonishing aspects, and where unequivocal demonstrations abound that fluids, as well as solids, are endowed with the principle of vital operations, "a principle distinct from all other powers of nature" (§ 64, 339). It is here, especially, that nature has illustrated her distinction between the animate and inanimate world, and established her chain of connection. It is here, in the incipient change of dead into living matter, that we witness a full display of those powers which operate in the most elaborate organization, and an equal exclusion of the forces which appertain to dead matter. It is here the line of separation begins abruptly; but where analogies are presented in the conversion of dead into living matter, through new modes of combining the same elements; and admiration increases, as we mount along the entire function of assimilation, and find, at each step of the ascending series, that the whole agency is committed to forces that have no existence in the inorganic world; that the whole is the harmonious result of a principle which may form an intermediate link between spirit and matter; and that there is no power within our control by which we can determine the nature of the changes.

Casting a glance at the vegetable world, we find the connection continued, by other analogous links, with elementary matter itself; but here, as in the higher department of nature, the line of separation is equally defined, however low in the scale of analogy may be the properties of life which have their beginning in vegetable organization.

It is here, then, at the threshold of life, as in the propagation of the species, that we especially witness a substitution of Creative Power; and, as all that appertains exclusively to the organic world was perfectly distinct in its Creation from the inorganic, so are the substituted processes of generation, and of the conversion of dead into living matter, equally distinct from the causes and results of inorganic processes (§ 32, &c., 63, &c.).

For conducting that connected series of changes which make up the process of assimilation in animals, a complex apparatus has been provided, whose beginning in the vegetable kingdom, and whose progressive development in the higher kingdom, have been contrived upon consummate principles of Design, that the elements of matter shall be gradually brought into those perfectly new conditions, both as to composition and properties, which contradistinguish the organic from the inorganic kingdoms, and thus, as in all things else in the natural world, that abrupt transmutation of inorganic into organic matter which distinguished the Creative Act shall be avoided, and remain a characteristic of Creative Power (§ 14, 172, 325).

337. In the early part of this work, I set forth some general facts which evince an incongruity of doctrines that clearly divides the physiological world into three schools; one of them (pure chemistry) making no distinction between the properties and laws of organic and inorganic beings; a second (pure vitalism) contradistinguishing the two kingdoms in those fundamental conditions; and the third (chemico-vitalism) blending the doctrines of chemistry and vitalism (§ 4½). Now, each of these denominations has interpreted the philosophy of digestion according to the general doctrines of life which are peculiar to each.

338. Beginning with pure chemistry, we find the great leader setting forth the process of digestion in the following language in his late work on *Animal Chemistry applied to Pathology and Therapeutics.*

"CHYMIFICATION," he says, "IS INDEPENDENT OF THE VITAL FORCE. It takes place in virtue of A PURELY CHEMICAL ACTION,—EXACTLY SIMILAR to those processes of decomposition and transformation which are known as PUTREFACTION, FERMENTATION, OR DECAY" (§ 365).

It will be also seen from the foregoing quotation, that the chemist is regardless of his own rules of philosophy, and of the fundamental principles of chemistry; since he identifies the organizing act, or that which combines the elements of matter into complex organic compounds, with the chemical process that resolves these compounds into their ultimate elements. We are told, indeed, that this is "experimental philosophy," and that, therefore, we must submit to it (§ 350).

339, *a.* I shall now set forth the exact doctrine of the vitalists relative to the physiology of digestion, in the language of the same distinguished "reformer" whom I have quoted in the preceding section. It is true, the doctrines are as fundamentally opposed as contradiction can possibly make them. But, as will have been abundantly seen, the most remarkable characteristic of the writings of this distinguished

man are their palpable contradictions. Nor can there be any proof so conclusive of the radical distinction between the philosophy of life and the philosophy of chemistry, about which "the reformer" was simultaneously concerned.

But, I will go back for a conflicting doctrine to the treatise "*on Organic Chemistry applied to Physiology*," published a year or two antecedently to his work "*on Animal Chemistry;*" by which we shall learn the extent of the confusion which pervades his writings, and the tardiness with which it is discerned by his medical disciples. In that work he says,

"The equilibrium in the chemical attractions of the constituents of food is disturbed BY THE VITAL PRINCIPLE. The UNION OF ITS ELEMENTS, so as to produce NEW COMBINATIONS AND FORMS, indicates the presence of A PECULIAR MODE OF ATTRACTION, *and the existence of* A POWER DISTINCT FROM ALL OTHER POWERS OF NATURE, namely, THE VITAL PRINCIPLE." "If the food possessed life, not merely the chemical forces, but THIS VITALITY would offer resistance to the *vital force* of the organism it nourished."—LIEBIG.

Such, then, is exactly the doctrine of the vitalist and solidist, mistaken by the chemist for his own, when he happened to be reasoning according to the promptings of organic nature. The same views are presented in the work on *Animal Chemistry* (§ 350).

339, *b*. And here, perhaps, it may be worth our while to say that the resuscitated chemical doctrine (§ 338) is apparently too wide a departure from fact even for that part of the British medical profession who have received most of the sayings of Liebig as oracular revelations; for we read in the late edition of the "*Pharmacologia*," now devoted to the authorized philosophy (§ 349 *d*, 676 *b*), that,

"According to the experiments of Spallanzani, and still more recently of Dr. Beaumont, if, after putrefaction has actually advanced, a substance in such a condition be introduced into the living stomach, the process is immediately checked, *and no signs of putrefaction are presented by the digested food*, although were the same substances left at the temperature of 99° F., they would soon evince evidence of its progress. It is therefore clear that the VITAL POWERS of the digestive organs must, in such cases, reverse or suspend the ordinary chemical affinities" (§ 676, *b*).—PARIS's *Pharmacologia*, p. 148. *London*, 1843. And such, in reality, is one of Liebig's conflicting statements.

And why should not the "vital powers reverse or suspend the ordinary chemical affinities" in all other cases of food, where it is far more obvious that such resistance does happen; and why may we not conclude that the law in relation to digestion has a wide foundation in living beings? Why does not the blood putrefy? Why not any other animal or vegetable fluid? Why not any living animal or vegetable solid?

340. Let us now hear the student of organic nature upon the physiology of digestion. What says John Hunter, of whom it is said by one, that "he stands alone in our profession;" that, "in his immense career, every thing bore reference to one great idea,—*the discovery and elucidation of nature's laws;*" "who," says another, "was neither anatomist, physiologist, surgeon, nor naturalist, alone, but the most remarkable combination of all these which the world has yet seen;"

for, "where," says another, "in the calendar of time, shall we look for an equal in the compass, the variety, and the depth of his researches into the mysteries of animal life, or for consequences such as those that have resulted from his labors to universal pathology;" while another apostrophizes, "how humble do any of the men of the present day appear when placed by the side of Hunter!" "The genius of Hunter," says another, "long ago explained the objections to other theories of digestion. These have been turned into ridicule to smooth the way for hypotheses that have no better foundation."

Well may we ask, what says John Hunter on the physiology of digestion?

"Digestion," he says, "is an assimilating process. It is a species of generation; but the curious circumstance is its converting both vegetable and animal matter into the same kind of substance or compound, which no chemical process can effect. Those who took it up *chemically, being ignorant of the principles of the animal economy,* have erroneously referred the operations of the animal machine to the laws of chemistry."

341. The illustrious George Fordyce, after a thorough experimental investigation of the subject, comes to the conclusion that,

"The changes which take place in the substances capable of giving nourishment, and, therefore, of being converted into the essential parts of the chyle, are TOTALLY DIFFERENT from those changes which take place any where but in the stomach, duodenum, and jejunum, *when alive.* Therefore, *no experiment made any where,* EXCEPTING IN THESE INTESTINES OF THE LIVING ANIMAL, *can in the smallest degree influence* the doctrine of digestion." "Food placed in all the chemical circumstances that can be conceived similar to those in which it is placed in the living animal, will never be converted into chyme, but will undergo other changes totally different." He finally adds, as the result of his own experiments out of the stomach, that, "*whether we employ the gastric juice, or bile, or saliva, in no case has* CHYLE, OR ANY THING LIKE IT, EVER BEEN PRODUCED." The reason is, that the gastric juice, like the blood, loses its vitality as soon as abstracted from the stomach. Hunter arrived at exactly the same conclusion from his observations (§ 365).

342. It is the opinion of Tiedemann, another distinguished inquirer into the nature of digestion (§ 340, 341), that,

"All the phenomena of digestion and assimilation, and which are only observed in living bodies, appear to rest, as to their foundation, on the VITAL PROPERTY which *organized liquids* possess of producing, under certain circumstances, in other organic matters, similar changes that cause these bodies to acquire the properties themselves are endowed withal." Again:

"It cannot be mistaken that digestion is an operation exclusively the property of living bodies, and *is in no way to be compared* with the changes of composition which general physical forces and the play of chemical are capable of producing in inorganic matters. It must be considered as a vital act, as an effect of life."

As to assimilation by vegetables, Tiedemann holds the same doctrine as Hunter, Fordyce, and all other physiologists whose opinions have survived the day on which they were promulgated. Thus:

"On the subject of the material changes which vegetable parts un-

dergo in nutrition, chemistry has hitherto given us no satisfactory information, simply because, *being effects of life, such changes are beyond the domain of chemical science.* All that we are authorized to admit is, that the changes of composition that occur during the nutrition of vegetables are the consequence of vital manifestations of activity, and not the effects of chemical affinities, such as are observed in inorganic bodies."

"All the attempts," he goes on, "of the intro-mechanicians and intro-chemists to reach this point (assimilation) have failed; and it is well ascertained that such ideas are both unsatisfactory and erroneous. We are therefore under the necessity of regarding them as effects, *sui generis*, as vital manifestations, founded on a power peculiar to, and inherent in, organic bodies."—TIEDEMANN'S *Physiology.*

343. Turning to the greatest of French physiologists, we hear from him the same general protest against the corruption of medicine by ingrafting upon it the physical sciences (§ 5½, *b*).

344. In considering farther the physiology of digestion, I shall introduce, in the first place, a series of general conclusions which have been derived from chemistry, both as to digestion and other organic processes, and when in this respect and otherwise prepared, I shall state the remaining grounds upon which I rely more specifically for establishing the vital doctrine.

345. Let us hear, then, the distinguished chemist, Dr. Prout, as the representative of those who mingle chemistry with vitalism.

"First," says Dr. Prout, "the stomach has the power of dissolving alimentary substances, or, at least, of bringing them to a semi-fluid state. This operation seems to be *altogether chemical.*

"2d. The stomach has, within certain limits, the power of changing into one another the simple alimentary principles," and "this part of the operation of the stomach appears, like the reducing process, to be *chemical;* but not so easy of accomplishment. It may be termed the converting operation of the stomach.

"3d. The stomach must have, within certain limits, the power of *organizing and vitalizing* the different alimentary substances." "It is *impossible to imagine* that this organizing agency of the stomach can be chemical. *Its agency is vital,* and its nature completely unknown."

346. Such, then, is the doctrine of digestion as entertained by the chemico-vitalist (§ 345). But, from what we shall have seen of the absolute contradictions which abound in the writings of those who attempt the application of pure chemistry to the functions and results of organic life, we may expect that the chemico-vitalist will be equally inconsistent when he applies himself, at one time, to the phenomena of living beings, and, at another, reasons from the results of the laboratory to those phenomena. Accordingly, we find within a few pages of the foregoing doctrine of the chemico-physiologist, that he broadly affirms that

"There is NO RELATION WHATEVER between the MECHANICAL arrangements and the CHEMICAL properties to which they administer." "There is NO REASON why the chemical changes of organization should result from the mechanical arrangements by which they are accomplished; neither is there the SLIGHTEST REASON, why the mechanical arrangements in the formation of organized beings should lead to the chemical changes of which they are the instruments"!

Here, then, in a single sentence, are not only the strangest contradictions, but a full admission that there is not the "slightest reason" for the application of chemistry to any process, function, or result of living beings.

347. Nor is that all. For the chemico-vitalist, the same eminent chemist whom I have just quoted, goes on to say, that "with the living, the animative properties of organic bodies, *chemistry has not the smallest alliance, and probably will never*, IN ANY DEGREE, *elucidate those properties*. The phenomena of life are not even REMOTELY ANALOGOUS to any thing we know in chemistry as exhibited among inorganic agents." And, as if to complete the overthrow of the chemical part of the philosophy of digestion, the same reasoner observes that, "the MEANS by which the peculiarities of composition and structure are produced, which is so remarkable in all organic substances, like the RESULTS themselves, are QUITE PECULIAR, and bear little or no resemblance to *any artificial process of chemistry*;" that "those who have attempted to apply chemistry to physiology and pathology *have split on a fatal rock* by hastily assuming that what they found by experiment to be wanting, or otherwise changed, in the animal economy, was the cause of particular diseases, and that such diseases were to be cured by supplying, and adjusting artificially, the principle in error. But the scientific physician will soon discover that Nature will not allow him to officiate as her journeyman, even in the *most trifling degree*."—DR. PROUT.

348. And, to the same effect may be quoted Dr. Carpenter, one of the foremost, as we have seen, in the school of pure chemistry (§ 64, *g*).

"The agency of VITALITY," says this reasoner, in his Comparative Physiology, where he generally ridicules the term and all that is relative to it, "*the agency of* VITALITY, as Dr. Prout justly remarks, does not change the properties of the elements, but simply COMBINES THE ELEMENTS *in modes which we cannot imitate*"!

So, also, Dr. Roget, alike distinguished in the school of chemico-vitalism (§ 64, *f*): "VITAL *chemistry*," he says, "*is* TOO SUBTLE A POWER *for human science to detect, or for human art to imitate*."

And thus the eminent Wagner, not less arrayed on the side of chemistry:

"The existence of one or more powers, commonly called VITAL powers, is not, however, denied. The FINAL CAUSE of the secretion of the gastric juice LIES IN THE NATURE OF THE ANIMAL ORGANISM, and is UNKNOWN to us."—WAGNER'S *Physiology*, *London*, 1842, p. 346. And yet this distinguished observer is one of the manufacturers of gastric juice.

349, *a*. Thus might I go on with one after another, till I should have exhausted the whole that have attempted to confound the science of life with the science of chemistry, and prove by their own statements that there is not the slightest intelligible connection between them. Indeed, I have already, in the Medical and Physiological Commentaries, pointed out this universal admission.

The ground of chemistry being thus virtually abandoned to the vitalist, it would seem superfluous to pursue an adversary who is always upon the retreat. But, as he flies, he is forever shooting from behind, and his Parthian weapons fall thickly and heavily upon the vast multitude. He must therefore be subdued intc a practical acqui-

escence with those consistent principles of nature which exact his consent, but not his compliance.

349, *b*. Perhaps no author has supplied so many examples of contradictions in great fundamental principles, and in so small a compass, as he who has so lately taken captive the physiological world. In the Preface to the Essays "*On the Philosophy of Vitality and the Modus Operandi of Remedial Agents*" I had occasion to say of the article on "Poisons, Contagions, and Miasma," in Liebig's "*Organic Chemistry applied to Agriculture and Physiology*," that "it is certainly the most stupendous exhibition of perverted facts, of combinations of conflicting doctrines, and of the rudest system of pathology and therapeutics, that can be found in the records of dreamy speculation."

It was objected by the editor of the *London Lancet*, that I did not prove my allegations (§ 5½, *a*). Nor was it in any respect the object of that work to do so. I was satisfied with calling attention to the facts, and with what I had already published in the Medical and Physiological Commentaries. Since that day, the work on "*Animal Chemistry*" has appeared; and it is now my purpose to sustain the allegations of the "Preface," and this more especially from the objections alleged by Liebig against physiologists (§ 350, *mottoes, a, b, c*, and *d*).

I say, therefore, that we meet on the same page a purely chemical and a purely vital philosophy of digestion; and equally so of other important organic processes. That each is laid down without qualification, and with the *dictum* of a master, who is conscious that the preponderance he gives to the purely chemical philosophy of life will establish his Empire in that philosophy with an age more prone than ever to the doctrines of materialism.

349, *c*. Let us, therefore, not be deceived; for, however this very extraordinary and successful pretender in medicine may beguile us with words, and seem to persuade rather than to rule, let us remember that, at most, he does but invalidate his own edicts by countermands, and that in the end he tells us that these apparently adverse decrees are, in their absolute import, one and the same; that they are consistent laws delivered from the laboratory, though apparently in conflict on account of the opposing forces, the attraction and repulsion, which preside in the chemistry of nature; that, however, in reality, there is no difference whatever in the seemingly two great principles which lie at the foundation, which are one and identical, since "*the mysterious vital principle can be replaced by the chemical forces;*" and since, also, "*the vital force unites in its manifestations all the peculiarities of the chemical forces, and of the no less wonderful cause which we regard as the ultimate origin of electrical phenomena.*" And again, "*in the processes of nutrition and reproduction, the ultimate cause of the different conditions of the vital force are chemical forces*" (§ 64, *e*).—Liebig's *Organic Chemistry;* and *Animal Chemistry.*

349, *d*. It is painful to speak thus of one so highly endowed, so devoted in mind, so accomplished in chemistry; but science and humanity demand the sacrifice. But, again, I wish to be understood, that neither here, nor in any other case, is it the individual of whom I speak, but of his doctrines alone (§ 1 *b*, 4 *b*). Nor yet would the doctrines of an individual become the subject of extended remark, did they not represent the existing state of the three high branches of medicine. The gigantic physical school had too much of the Pro

tean character, too little unity of purpose, and demanded greater stability. The learned men of a great Nation, *The British Association for the Advancement of Knowledge*, united in the object, and bestowed the honor of achieving the enterprise upon a foreign Chemist. The note of proscription has been sounded in high quarters, in due conformity (§ 5½ *a*, 150¾ *kk*), and medical philosophy has nothing to hope even from a spirit of toleration. The subject, therefore, must be brought to the test of observation and reason, and he who arraigns the authorized doctrines will cheerfully abide an unsuccessful issue (§ 1 *b*, 676 *b*, 709, *note*). I shall therefore dwell upon the conclusions of those who have engendered the corruptions, and shall array them in all the force demanded by the magnitude of my subject, that we may the better realize the shallowness of that pretended philosophy which has so lately swept, like a hurricane, over the intellectual world, that we may see, in the system of contradictions, the equal fallacy of that school who endeavor, with great sincerity, to mingle the conflicting principles, and that we may the better cultivate and enjoy the simple and consistent philosophy which nature teaches. Nor will I yet leave their general reference to that stupendous system of assumption and contradiction which was so lately hailed by physiologists as the harbinger of a total revolution in medical science, ay, in the very practice of medicine, without showing you the depth of the materialism in which it was submerged. I say nothing now of the avowed infidelity to which it has led. Examples of that disregard of instinctive faith I have already placed in their proper connection with my subject.* But, I will merely present, in relief, from Liebig's revolutionary work, a doctrine of the chemical school, from which, if I mistake not the ambition of intellectual and immortal beings, the very impulse of nature will turn the most indifferent with a loathing aversion. We shall see from it, also, how entirely degraded to the rank of the merest matter is every thing relating to organic life; even man himself. Thus, then, "the Reformer," in behalf of the school of chemistry:

349, *e.* "Physiology has sufficiently decisive grounds for the opinion that *every motion, every manifestation of force*, is the RESULT of a transformation of the structure or of its substance; that every conception, every mental affection, is followed by changes in the chemical nature of the secreted fluids; that every thought, every sensation, is accompanied by A CHANGE IN THE COMPOSITION OF THE SUBSTANCE OF THE BRAIN." "*Every manifestation of force is the* RESULT *of a transformation of the structure or of its substance.*"

And now may it not be reasonably asked, what is the cause of those chemical changes in the cerebral substance which give rise to "every conception, every mental affection, every thought, and every sensation" (§ 175 *c*, 500 *n*)?

Many organic chemists, however, are disposed to admit a spiritual part, and they should therefore recollect that the existence of a principle of life is not less substantiated by facts than the existence of the soul, which they are so ready to concede when inviting our attention to the physical doctrines of life.

350. I have just said that I would present such an array of contra-

* See *Medical and Physiological Commentaries*, vol. ii., p. 122–140. Also, the *Essay on the Vital Powers*, in vol. i.

dictory opinions on the physiology of digestion, and the general philosophy of life and disease, from the two brief National Essays by Liebig (§ 349, *d*), as should induce physiologists to retrace their steps, and thus make some atonement to the science which was surrendered with an acclamation that had been worthy the original institution of medicine.

In the first place, however, with a view to the cause which I advocate, and in justice, also, to able and independent philosophers, I shall quote the following remarks from a letter addressed to myself by a distinguished writer, of Manchester (England):

"Manchester, May 5, 1846.

"DEAR SIR,

"*I made your pamphlet* (a Lecture on Digestion) *the subject of a Paper which I read before the* MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY, *and which provoked a discussion two nights. The result was almost unanimously in favor of your views in reference to the Philosophy of Digestion. I am*, &c.,

"CHARLES CLAY, M.D."

I shall now exhibit, in parallel columns, the new philosophy which forms the present science of medicine, preceded by some appropriate *mottoes*.

a. "ANIMAL and VEGETABLE physiologists institute experiments without being acquainted with the circumstances necessary to the continuance of life—with the qualities and proper nourishment of the animal or plant on which they operate—or with the nature and chemical constitution of its organs. These experiments are considered by them as convincing proofs, while they are fitted only to awaken pity" (no. 50).

b. "ALL DISCOVERIES in physics and in CHEMISTRY, all explanations of CHEMISTS [!], must remain without fruit and useless, because even to the GREAT LEADERS IN PHYSIOLOGY, carbonic acid, ammonia, acids, and bases, are sounds without meaning, words without sense, terms of an unknown language, which awaken no thoughts, and no associations. They treat these sciences like the vulgar, who despise a foreign literature in exact proportion to their ignorance of it."—LIEBIG'S *Organic Chemistry applied to Physiology*, &c. [See no. 2.]

c. "None of them (the most distinguished physiologists) had a clear conception of the process of development and nutrition, or of the true cause of death. They professed to explain the most obscure *psychological* phenomena, and yet they were unable to say what fever is, and in what way quinine acts in curing it" (no. 2, 40). The oft-reiterated conclusion follows, that IT IS RESERVED FOR CHEMISTRY TO RESOLVE THESE PROBLEMS.

d. "Thus *medicine*, after the fashion of the Aristotelian philosophy, has formed certain conceptions in regard to NUTRITION and SANGUIFICATION. *Articles of diet* have been divided into NUTRITIOUS and NON-NUTRITIOUS; but these THEORIES [!] being founded on observations DESTITUTE of the conditions most essential to the drawing of just conclusions, could not be received as expressions of the truth. How clear are now to us the relations of the different articles of food to the objects which they serve in the body, since *organic chemistry* has applied to the investigation her quantative method of research"! (§ 18, 409.)

e. "The limited acquaintance of physiologists with the methods of research employed in chemistry WILL CONTINUE TO BE the chief impediment to the progress of physiology, as well as a reproach which that science cannot escape."—LIEBIG'S *Animal Chemistry*.

f. "What has the SOUL, what have consciousness and intellect to do with the development of the human fœtus, or the fœtus in a fowl's egg? Not more, surely, than with the development of the seeds of a plant. Let us first endeavor to refer to their ultimate causes those phenomena of life which are not psychological; and *let us beware of drawing conclusions before we have a ground-work.* We know exactly the mechanism of the eye; but neither anatomy nor CHEMISTRY will ever explain how the rays of light act on consciousness, so as to produce vision. Natural science has fixed limits which cannot be passed; and it must always be borne in mind that, with all our discoveries, we shall never know what light, electricity, and magnetism are in their essence, because, even of those things which are material, the human intellect has only conceptions. We can ascertain, however, the laws which regulate their motion and rest, because these are manifested in phenomena. IN LIKE MANNER, THE LAWS OF VITALITY, AND OF ALL THAT DISTURBS, PROMOTES, OR ALTERS VITALITY, may certainly be discovered, although we shall never learn what life is" (§ 168, *h*).—LIEBIG'S *Animal Chemistry*.

g. "A writer, who can so contradict himself, scarcely needs to be exposed by us."—CARPENTER'S *Review of* PAINE'S "*Commentaries.*" See PAINE'S "*Examination of Reviews,*" p. 12, 86.

h. "Chemists and natural philosophers, accustomed to study the phenomena over which the physical forces preside, have carried their spirit of calculation into the theories of the vital laws."—BICHAT'S *General Anatomy*, vol. ii., p. 54.

i. "Let a man be given up to the contemplation of one sort of knowledge, and that will become every thing. The mind will take such a tincture from a familiarity with that object, that every thing else, how remote soever, will be brought under the same view. A metaphysician will bring ploughing and gardening immediately to abstract notions; the history of nature will signify nothing to him. A chemist, on the contrary, shall reduce divinity to the maxims of his laboratory, explain morality by *sal, sulphur,* and *mercury,* and allegorize the Scripture itself, and the sacred mysteries thereof, into the philosopher's stone."—LOCKE, *on the Human Understanding.*

k. "Mr. Locke, I think, mentions an eminent musician, who believed that God created the world in six days, and rested on the seventh, because there are but seven notes in music. I myself knew one of that profession who thought there were only three parts in harmony, to wit, base, tenor, and treble, because there are but three persons in the Trinity."—REID, *on the Powers of the Human Mind*, vol. ii., *Essay* 6, c. viii.

l. "When education takes in error as a part of its system, there is no doubt that it will operate with abundant energy, and to an extent indefinite."—BURKE (§ 675).

CHEMICAL DOCTRINES.

1. "MY OBJECT has been, in the present work, to direct attention to the points of intersection of *chemistry with physiology*, and to point out those parts in which the sciences become, as it were, *mixed up together*. It contains a collection of problems, such as *chemistry* at present requires to be resolved, and a number of conclusions drawn *according to the rules* of that science. These questions and problems will be resolved; and we cannot doubt that we shall have in that case A NEW PHYSIOLOGY AND A RATIONAL PATHOLOGY."—LIEBIG'S *Animal Chemistry.*

2. "In *earlier times*, the attempt has been made, and OFTEN WITH GREAT SUCCESS, to apply to the objects of the *medical* art the views derived from an acquaintance with *chemical* observations. Indeed, the great PHYSICIANS, who lived toward the end of the 17th century, were the FOUNDERS OF CHEMISTRY, AND IN THOSE DAYS THE ONLY PHILOSOPHERS ACQUAINTED WITH IT."—LIEBIG'S *Animal Chemistry.* (See mottoes *b*, *e*.)

3. "In the *animal body* we recognize as the ultimate *cause of all*

VITAL DOCTRINES.

47. "A RATIONAL physiology cannot be founded on mere reactions, and the living body cannot be viewed AS A CHEMICAL LABORATORY."

"The study of the USES of the functions of different organs, and of their MUTUAL CONNECTION in the animal body, was formerly the chief object in physiological researches; but lately THIS STUDY has fallen into the back-ground."—LIEBIG'S *Animal Chemistry.*—(See motto *c*.)

48. "WITH ALL ITS DISCOVERIES, *Modern Chemistry* has performed but SLENDER SERVICES to physiology and pathology."—LIEBIG, *ibid.*

49. "*Physiology* still endeavors to apply *chemical experiments* to the removal of diseased conditions; but, with all these COUNTLESS EXPERIMENTS, we are not ONE STEP NEARER to the *causes and essence of disease.*"—LIEBIG, *ibid.*

50. "Mechanical philosophers and CHEMISTS *justly* ascribe to THEIR methods of research the greater part of the success which has attended their labors."—LIEBIG'S *Animal Chemistry* (*a*).

51. "In the *animal ovum*, as well as in THE SEED OF A PLANT,

CHEMICAL DOCTRINES.

force only *one cause*, the CHEMICAL ACTION which the elements of the food and the oxygen of the air mutually exercise on each other. The only known ultimate *cause* of vital force, either in animals or in plants, is A CHEMICAL PROCESS. If THIS be *prevented*, THE PHENOMENA OF LIFE DO NOT MANIFEST THEMSELVES. If the *chemical action* be *impeded*, the vital phenomena must take *new forms*." "ALL VITAL ACTIVITY ARISES from the mutual action of the oxygen of the atmosphere and the elements of the food."—LIEBIG'S *Animal Chemistry*.

4. "THE LIFE of animals exhibits itself in the continual absorption of the oxygen of the air, and its combination with certain parts of the animal body."—LIEBIG'S *Animal Chemistry*.

5. "Physiology has sufficiently decisive grounds for the opinion, that EVERY MOTION, EVERY MANIFESTATION OF FORCE, IS THE RESULT OF A TRANSFORMATION OF THE STRUCTURE OR OF ITS SUBSTANCE; that *every conception, every mental affection*, is followed by *changes* in the chemical nature of the secreted fluids; that *every thought, every sensation*, is accompanied by a change in the *composition* of the substance of the brain"! —LIEBIG'S *Animal Chemistry* (no. 41, 18½).

5½. *Nevertheless*, "*we ascribe the higher phenomena of mental existence to* AN IMMATERIAL AGENCY, *and that, in so far as its manifestations are connected with matter, an agency* ENTIRELY *distinct* FROM THE VITAL FORCE, *with which it has nothing in common*."—LIEBIG'S *Animal Chemistry*.

VITAL DOCTRINES.

we recognize A CERTAIN REMARKABLE FORCE, THE SOURCE OF GROWTH, or increase in the mass, and of reproduction, or of supply of the matter consumed; A FORCE IN A STATE OF REST. By the action of external influences, by impregnation, by the presence of air and moisture, the condition of STATIC EQUILIBRIUM of this force is disturbed. ENTERING INTO A STATE OF MOTION OR ACTIVITY, *it exhibits itself* IN THE PRODUCTION *of a series of forms*, which, although occasionally bounded by right lines, are yet widely distinct from geometrical forms, such as we observe in crystalized minerals. This force is called THE VITAL FORCE, *vis vitæ*, OR VITALITY." "The *increase* of mass is effected in living parts by the VITAL FORCE."—LIEBIG'S *Animal Chemistry*. (See my *Essays on Vitality*, &c., p. 13–18.)

51½. "The OXYGEN of the atmosphere is the proper, active, external cause of the WASTE of matter in the animal body. It acts like a force which tends to disturb and DESTROY the manifestations of the VITAL FORCE at every moment. But its effect as a chemical agent (in producing *waste*), the disturbance proceeding from it, IS HELD IN EQUILIBRIUM BY THE VITAL FORCE."—LIEBIG'S *Animal Chemistry*.

52. "The vital force is manifested in the form of RESISTANCE, inasmuch as by its presence in the living tissues, *their elements acquire the power of withstanding the disturbance and change in their form and* COMPOSITION, which external agencies tend to produce; A POWER, which, as CHEMICAL COMPOUNDS, THEY DO NOT POSSESS." —LIEBIG'S *Animal Chemistry*.

53. "The VITAL PRINCIPLE must be a MOTIVE POWER, CAPABLE OF

CHEMICAL DOCTRINES.

6. "In the processes of NUTRITION and REPRODUCTION, we perceive the passage of matter from the state of motion to that of rest (static equilibrium). Under the influence of the nervous system, this matter enters again into a state of motion. The ultimate causes of these different conditions of the vital force are CHEMICAL FORCES."

7. "THE CAUSE of the state of MOTION is to be found in a series of changes which the food undergoes in the organism, and these are the RESULTS OF PROCESSES OF DECOMPOSITION, to which either the food itself, or the STRUCTURES formed from it, or parts of organs, are subjected."

8. "The change of matter, the manifestation of mechanical force, and the absorption of oxygen, are, in the animal body, so closely connected with each other, that we may consider the AMOUNT OF MOTION and the QUANTITY OF LIVING TISSUE TRANSFORMED, AS PROPORTIONAL TO THE QUANTITY OF OXYGEN inspired and consumed in a given time by the animal."—LIEBIG'S *Animal Chemistry* (no. 3, 4).

9. "If we employ these well-known facts as means to assist us in investigating the ultimate cause of the mechanical effects in the animal organism, observation teaches us that the MOTION OF THE BLOOD AND OF THE OTHER ANIMAL FLU-

VITAL DOCTRINES.

IMPARTING MOTION TO ATOMS AT REST, and of OPPOSING RESISTANCE to OTHER forces producing motion, such as THE CHEMICAL FORCE, heat and ELECTRICITY."—LIEBIG'S *Lectures for* 1844.

"EVERY THING in the organism goes on *under the influence* of the VITAL FORCE, AN IMMATERIAL AGENT, which the chemist cannot employ at will."—LIEBIG'S *Animal Chemistry*.

54. "There is NOTHING to prevent us from considering the VITAL FORCE as a PECULIAR property, which is possessed by certain material bodies, and becomes sensible when their elementary particles are combined in a certain arrangement or form. This supposition takes from the *vital phenomena* nothing of their wonderful peculiarity. It may, therefore, be considered as a RESTING POINT from which an investigation into these phenomena, and the LAWS which regulate them, may be commenced; exactly as we consider the properties and laws of LIGHT to be dependent on a certain *luminiferous matter* or other, which has no farther connection with the laws ascertained by investigation."—LIEBIG'S *Animal Chemistry*.

55. "EVERY THING in the animal organism, to which the name of MOTION can be applied, proceeds from the NERVOUS apparatus." "In animals we recognize in the *nervous apparatus* A SOURCE OF POWER CAPABLE OF RENEWING ITSELF at every moment of their existence." — LIEBIG'S *Animal Chemistry*.

56. "We may communicate MOTION to a body at rest by means of a *number of forces*, very different in their manifestations. Thus, a time-piece may be set in motion by a falling weight (*gravitation*), or by a bent spring (*elasticity*).

CHEMICAL DOCTRINES.

IDS proceeds from distinct organs, which, as in the case of the HEART and intestines, DO NOT GENERATE THE MOVING POWER IN THEMSELVES, BUT RECEIVE IT FROM OTHER QUARTERS."—LIEBIG'S *Animal Chemistry* (no. 3, 4).

10. "Now, since the phenomena of MOTION in the animal body ARE DEPENDENT ON THE CHANGE OF MATTER, the increase of the change of matter in any part is followed by an increase of all the motions. Consequently, if, in consequence of a DISEASED TRANSFORMATION OF LIVING TISSUES, a greater amount of force be generated than is required for the production of the normal motions, it is seen IN THE ACCELERATION OF ALL OR SOME OF THE INVOLUNTARY MOTIONS, as well as in a HIGHER TEMPERATURE OF THE DISEASED PART."—LIEBIG'S *Animal Chemistry.* [*Such, with* § 350½, *no.* 11, *and a, is the chemical substitute for the medical aphorism, "ubi irritatio ibi affluxus." It will be also seen from the foregoing nos.* 7, 8, 9, *that Liebig considers the circulation of the blood due to the agencies of oxygen, and not at all to the action of the heart.*]

11. "THE POWER to effect TRANSFORMATIONS *does not belong to the vital principle.* Each transformation is owing to a disturbance in the attraction of the elements of a compound, and is, consequently, A PURELY CHEMICAL PROCESS." — LIEBIG'S *Organic Chemistry applied to Physiology*, &c.

12. "The combinations of the CHEMIST relate to the change of matter, *forward and backward*, TO THE CONVERSION OF FOOD INTO THE VARIOUS TISSUES and secretions, and to their metamorphosis into *lifeless compounds;* HIS INVESTIGATIONS *ought to tell us* WHAT HAS

VITAL DOCTRINES.

Every kind of motion may be produced by the *electric* or *magnetic* force, as well as by *chemical attraction;* while we cannot say, as long as we only consider the manifestation of these forces in the phenomenon or result produced, which of these various causes of change of place has set the objects in motion. IN THE ANIMAL ORGANISM we are acquainted with ONLY ONE CAUSE OF MOTION, and this is the SAME CAUSE which *determines the growth* of living tissues and gives them *the power of resistance* to external agencies. IT IS THE VITAL FORCE."—LIEBIG, *ibid.*

57. "In order to attain *a clear conception* of these manifestations of THE VITAL FORCE, SO DIFFERENT in form, we must bear in mind, that every known force is recognized by two conditions of activity," &c.—LIEBIG'S *Animal Chemistry.*

58. "Our notion of life involves something more than mere reproduction, namely, the idea of AN ACTIVE POWER exercised by virtue of a definite form, and production and generation in a definite form. The production of organs, and their power not only to produce their component parts from the food presented to them, but to GENERATE THEMSELVES *in their original form* and *with all their properties*, are characters BELONGING EXCLUSIVELY TO ORGANIC LIFE, and constitute a form of reproduction INDEPENDENT OF CHEMICAL POWERS. The chemical forces are sub-

CHEMICAL DOCTRINES.

TAKEN PLACE AND WHAT CAN TAKE PLACE IN THE BODY."—LIEBIG'S *Animal Chemistry.*

13. "How beautifully and admirably SIMPLE, with the aid of these discoveries (*chemical*), appears the process of NUTRITION in animals, the FORMATION OF THEIR ORGANS," &c.

14. "In the hands of the physiologist, ORGANIC CHEMISTRY must become an intellectual instrument, by means of which he will be enabled to trace the CAUSES of phenomena INVISIBLE to the bodily sight."—LIEBIG'S *Animal Chemistry.*

15. "The self-regulating STEAM-ENGINES furnish no unapt image of what occurs in the *animal body.*" "The body, in regard to the production of HEAT and FORCE, *acts just like one of these machines.*"—LIEBIG'S *Animal Chemistry.*

16. "THE VITAL FORCE UNITES in its manifestations ALL THE PECULIARITIES OF CHEMICAL FORCES, and of the not less wonderful CAUSE which we regard as the ultimate origin of ELECTRICAL phenomena."—LIEBIG'S *Animal Chemistry.*

17. "The mysterious VITAL

VITAL DOCTRINES.

ject TO THE INVISIBLE CAUSE BY WHICH THIS FORM IS PRODUCED. OF THE EXISTENCE OF THIS CAUSE ITSELF we are made aware ONLY *by the phenomena* which IT PRODUCES. ITS LAWS must be investigated *just* as we investigate THOSE of the OTHER POWERS which effect motion and changes in matter."—LIEBIG'S *Organic Chemistry applied to Physiology,* &c.

59. "It is not the true chemist who has endeavored to apply to the animal organism his notions derived from purely chemical processes. He has not had the remotest intention of undertaking the explanation of any really vital phenomenon, upon chemical principles. The only part which chemistry now, or for the future, can take in the explanation of the vital processes, is limited to a more precise designation of the phenomena, and to the task of controlling the correctness of inferences, and insuring the accuracy of all observations by number and weight. Although the chemist is able to analyze organic bodies, and tell us their ultimate elements, he does not claim the power of synthesis, or of producing them again by the union of these elements" !!! —LIEBIG'S *Lectures for* 1844 (§ 350½–350⅔).

60. "IN WHAT FORM OR IN WHAT MANNER THE VITAL FORCE PRODUCES MECHANICAL EFFECTS IN THE ANIMAL BODY IS ALTOGETHER UNKNOWN, AND IS AS LITTLE TO BE ASCERTAINED BY EXPERIMENT AS THE CONNECTION OF CHEMICAL ACTION WITH THE PHENOMENA OF MOTION, which we can produce with the galvanic battery. We know not how a *certain invisible something, heat,* gives to certain bodies the power of exerting an enormous pressure on surrounding objects. We know not even

CHEMICAL DOCTRINES.

PRINCIPLE can be REPLACED by the CHEMICAL FORCES."—LIEBIG'S *Organic Chemistry applied to Physiology*, &c.

17½. "The high temperature of the animal body is *uniformly and under all circumstances* the result of the combination of a combustible substance with oxygen."

"The CARBON of the food, which is converted into CARBONIC ACID within the body, must give out *exactly as much heat* as if it had been directly burned in the air, or in oxygen gas. The *only difference is*, that the amount of heat produced is diffused over unequal times."

"By the combination of oxygen with the constituents of the metamorphosed tissues, the TEMPERATURE NECESSARY TO THE MANIFESTATIONS OF VITALITY is produced in the carnivora."—LIEBIG'S *Animal Chemistry* (§ 440, nos. 17 and 18).

18. "The NERVES which accomplish the voluntary and involuntary MOTIONS in the body (no. 7–9) are, according to the preceding exposition, NOT THE PRODUCERS, but ONLY THE CONDUCTORS OF THE VITAL FORCE (§ 59). They permit

VITAL DOCTRINES.

HOW *this something* itself is produced when we burn wood or coals.

"So it is with THE VITAL FORCE, and with THE PHENOMENA exhibited by living bodies. The CAUSE of these PHENOMENA IS NOT CHEMICAL force; IT IS NOT ELECTRICITY, nor magnetism. It is a PECULIAR FORCE, because it exhibits manifestations which are formed by NO OTHER KNOWN FORCE."

61. "In regard to the NATURE AND ESSENCE of the vital force, we can hardly deceive ourselves, when we reflect, that it behaves, in all its manifestations, exactly like OTHER natural forces; that it is devoid of consciousness or of volition, and is *subject to the action of a* BLISTER." — LIEBIG'S *Animal Chemistry*.

61½. "Certain other constituents of the blood may give rise to the formation of CARBONIC ACID IN THE LUNGS. But, all this has NO CONNECTION with that VITAL PROCESS BY WHICH THE HEAT necessary for the support of life IS GENERATED in every part of the body." —LIEBIG'S *Animal Chemistry*.

62. "In the present state of our knowledge, *no one*, probably, WILL IMAGINE that ELECTRICITY is to be considered AS THE CAUSE of the phenomena of MOTION in the body." "*Every thing* in the animal organism to which the name

CHEMICAL DOCTRINES.

the current to traverse them, and present, as CONDUCTORS OF ELECTRICITY, ALL THE PHENOMENA WHICH THEY EXHIBIT AS CONDUCTORS OF THE VITAL FORCE"!—LIEBIG's *Animal Chemistry.* [Compare with no. 55.]

18½. "If CHEMICAL ACTION be excluded as a condition of *nervous agency*, it means nothing else than to derive the presence of MOTION, the MANIFESTATION OF FORCE, FROM NOTHING. BUT NO FORCE, NO POWER, CAN COME FROM NOTHING"!—LIEBIG's *Animal Chemistry* (no. 5).

19. "By means of the NERVES, ALL PARTS of the body receive the moving force which is INDISPENSABLE to their functions, to change of place, to the production of mechanical effects. *Where nerves are not found, motion does not occur.* [In plants, for example?] The excess of force generated in one place is conducted to other parts by the nerves. The force which one organ cannot produce in itself is conveyed to it from other quarters, [!] and the vital force which is wanting to it, in order to furnish resistance to external causes of disturbance, it receives in the form of excess from another organ, an excess which that organ cannot consume in itself"!—LIEBIG's *Animal Chemistry* (§ 422, 423, 733 *e*).

20. "The phenomena of MOTION IN VEGETABLES, the circulation of the sap, for example, observed in many of the characeæ, and the closing of flowers and leaves, depend on PHYSICAL and MECHANICAL causes. HEAT and LIGHT are the REMOTE CAUSES of MOTION in VEGETABLES; but in ANIMALS we recognize in the *nervous apparatus* A SOURCE OF POWER, capable of renewing itself at every moment of their existence."—LIEBIG's *Animal Chemistry.*

21. "While the ASSIMILATION

VITAL DOCTRINES.

of MOTION can be applied *proceeds from the nervous* apparatus. In animals we recognize in the *nervous apparatus* A SOURCE OF POWER, CAPABLE OF RENEWING ITSELF at every moment of their existence."—LIEBIG's *Animal Chemistry* (no. 55).

63. "Pathology informs us that the true *vegetable life* is in NO WAY dependent on THIS APPARATUS (the cerebro-spinal); that the process of nutrition proceeds in those parts of the body where the NERVES of sensation and voluntary motion are paralyzed, exactly in the same way as in other parts where these nerves are in the normal condition; and, on the other hand, that the most energetic volition is incapable of exerting any influence on the contractions of the heart, on the motion of the intestines, or on the processes of secretion."—LIEBIG's *Animal Chemistry.*

64. "Although plants require LIGHT, and, indeed, sun light, it is not necessary that the direct rays of the sun reach them. Their FUNCTIONS certainly proceed with greater intensity and rapidity in sunshine, than in the diffused light of day; but it merely ACCELERATES in a greater degree THE ACTION ALREADY EXISTING." — LIEBIG's *Organic Chemistry applied to Physiology*, &c.

65. "THE VITAL PRINCIPLE is ONLY known to us through the peculiar form of ITS INSTRUMENTS;

CHEMICAL DOCTRINES.

of food in VEGETABLES, and the WHOLE PROCESS OF THEIR FORMATION, are DEPENDENT on certain EXTERNAL INFLUENCES *which produce motion*, the *development* of the ANIMAL organism is, to a certain extent, *independent* of those external influences, just BECAUSE the ANIMAL body can produce WITHIN ITSELF THAT SOURCE OF MOTION WHICH IS INDISPENSABLE TO THE VITAL PROCESS."—LIEBIG'S *Animal Chemistry.*

22. "Neither the emission of carbonic acid nor the absorption of oxygen (by *plants*) has any connection with the process of ASSIMILATION; nor have they the slightest relation to each other. The one is *purely a mechanical*, the other a *purely chemical process.* A COTTON WICK, inclosed in a lamp, which contains a liquid saturated with carbonic acid, acts *exactly* in the same manner as a living plant in the night."—LIEBIG'S *Organic Chemistry applied to Physiology*, &c.

23. "At night, a true CHEMICAL process COMMENCES, in consequence of the action of the oxygen of the air upon the substances composing the leaves, blossoms, and fruit. This process is not at all connected with the life of the vegetable organism, because it goes on in the DEAD plant EXACTLY as in a *living* one"!

Nevertheless,

23½. "What value can be attached to experiments, in which all those matters which *a plant* REQUIRES in the process of ASSIMILATION, besides its MERE NUTRIMENT, have been EXCLUDED WITH THE GREATEST CARE? Can the LAWS OF LIFE be investigated in an organized being which is diseased or DYING?"—LIEBIG'S *Organic Chemistry applied*, &c.—Or, can those laws be investigated in

VITAL DOCTRINES.

that is, through the organs IN WHICH IT RESIDES. Hence, whatever kind of energy a substance may possess, if it is amorphous and destitute of ORGANS from which the IMPULSE, MOTION, OR change, proceeds, IT DOES NOT LIVE. Its ENERGY depends, in THIS CASE, on a CHEMICAL ACTION. LIGHT, HEAT, electricity, or other *influences* [justly considered *here* by Liebig as vital *stimuli* and *not forces*] may increase, diminish, or arrest THIS ACTION; but they ARE NOT ITS EFFICIENT CAUSE." "THE VITAL PRINCIPLE OPPOSES to the continual action of the atmosphere, moisture, and temperature, upon the organism, A RESISTANCE which is, in a certain degree, *invincible.* It is by the *constant neutralization* and *renewal* of these external influences that *life and motion are maintained.*" — LIEBIG'S *Organic Chemistry applied to Physiology*, &c. (§ 188½, *d*).

66. "An abnormal production of certain component parts of plants *presupposes* A POWER AND CAPABILITY OF ASSIMILATION, to which the most powerful CHEMICAL ACTION CANNOT BE COMPARED. The best idea of it may be formed, by considering that it surpasses in power the strongest galvanic battery, with which we are not able to separate the oxygen from carbonic acid, as is done by the *leaves of plants*," "and without the direct solar rays."

67. "All that we can do is to supply those substances which are adapted for ASSIMILATION BY THE POWER *already present* in the organs of the plant."—LIEBIG'S *Organic Chemistry applied to Physiology*, &c.

68. "The living part of a plant acquires the whole force and direction of its VITAL ENERGY from the absence of all conductors of force. BY *this means* the *leaf* is

CHEMICAL DOCTRINES.

"*a cotton wick*, inclosed in a lamp?"

And so of animals.

24. "The permeability to gases is a mechanical property, *common to* ALL ANIMAL tissues; and is found in the SAME DEGREE in the LIVING as in the DEAD tissue"!—LIEBIG'S *Animal Chemistry* (§ 350½, *n*, and *Medical and Physiological Commentaries*, vol. i., p. 565, 569, *notes*, 683–690).

25. "Analogy, that fertile source of error, has unfortunately led to the very UNAPT COMPARISON of the VITAL functions of PLANTS with those of ANIMALS."—LIEBIG'S *Organic Chemistry applied to Physiology*, &c.

26. "ALL SUBSTANCES IN SOLUTION IN A SOIL ARE ABSORBED BY THE ROOTS OF PLANTS, EXACTLY AS A SPONGE IMBIBES A LIQUID, AND ALL THAT IT CONTAINS, WITHOUT SELECTION," and "THEIR ASSIMILATION is a PURELY CHEMICAL PROCESS."—IBID. (no. 22, § 289–291).

Nevertheless,

VITAL DOCTRINES.

enabled to overcome the *strongest chemical attractions*, to DECOMPOSE CARBONIC ACID, and to ASSIMILATE the ELEMENTS of its nourishment."—LIEBIG'S *Animal Chemistry*.

69. "In vegetable physiology, a leaf is regarded in every case *merely as a leaf*, notwithstanding that leaves generating oil of turpentine or oil of lemons, *must possess a differeut nature* from those in which oxalic acid is formed. VITALITY, in its *peculiar operations*, MAKES USE of a SPECIAL apparatus for *each* function of an organ. Vegetable physiologists, in the study of their science, have not directed their attention to *that part* of it (the laws of vitality) which is *most worthy* of investigation."—LIEBIG'S *Organic Chemistry applied to Physiology*, &c.

70. "In the living plant, the INTENSITY of the VITAL FORCE far exceeds that of the CHEMICAL ACTION of oxygen. We know, with the UTMOST CERTAINTY, that, by the influence of the VITAL FORCE, OXYGEN is separated FROM ELEMENTS to which it has the strongest affinity; and that it is given out in the gaseous form, without exerting the slightest action on the juices of the plant."—LIEBIG'S *Animal Chemistry*.

71. "THE ANIMAL ORGANISM IS A HIGHER KIND OF VEGETABLE."

"ASSIMILATION, or the process of FORMATION and GROWTH, goes on in the SAME WAY in ANIMALS and in VEGETABLES. In both the SAME CAUSE determines the increase of mass. This constitutes the TRUE vegetative life."—LIEBIG'S *Animal Chemistry*.

72. "The CONSTITUENTS of VEGETABLE and animal substances *are formed* under the guidance and power of THE VITAL PRINCIPLE, which *determines* the direction of their molecular *attraction*." "In

CHEMICAL DOCTRINES.

26½. "When roots FIND their MORE APPROPRIATE BASE in sufficient quantity, they will take up LESS OF ANOTHER."—*And, again* (*in opposition to the simile of the "sponge," and "lamp-wick"*) : "It is thought very remarkable, that those PLANTS of the grass tribe, the seeds of which furnish food for man, *follow him like the domestic animals.* But *saline* plants *seek the sea-shore* or *saline springs*, and the *Chænopodium the dung-hill* from similar causes. Saline plants require common salt, and plants which grow on dung-hills, only, need ammonia and nitrates, and they are attracted whither these can be found, *just as* the dung-fly is to animal excrements." "The roots of plants are constantly engaged in *collecting* from the rain those *alkalies* which formed part of the sea-water, and also those of the water of springs which penetrates the soil."

27. "Each new *radical fibril* which a plant acquires may be regarded as constituting, at the same time, A MOUTH, A LUNG, and A STOMACH. The *roots* perform the functions of the *leaves* from the first moment of their formation; they EXTRACT from the soil their proper nutriment, namely, the CARBONIC ACID generated by the humus."—LIEBIG'S *Organic Chemistry applied to Physiology.*

28. ["*Nature speaks to us in a peculiar language, in the language of phenomena. She answers, at all times, the questions which are put to her; and such questions are experiments. An experiment is the expression of a thought. We are nearer the truth,* WHEN THE PHENOMENON, *elicited by the* EXPERIMENT, CORRESPONDS TO THE THOUGHT; *while* THE OPPOSITE *result shows that the question was* FALSELY STATED, *and that the conception was*

VITAL DOCTRINES.

the formation of *vegetable* and animal substances, THE VITAL PRINCIPLE opposes, as a FORCE OF RESISTANCE, the action of the OTHER FORCES," &c.—LIEBIG'S *Lectures for* 1844.

73. "THE FORCE which gives to the germ, the leaf, and the RADICAL FIBRES of the VEGETABLE THE SAME WONDERFUL PROPERTIES (digestion, circulation, and secretion), IS THE SAME as THAT residing in the secreting membranes and glands of ANIMALS, and which enables every animal organ to perform its own proper functions."—LIEBIG'S *Animal Chemistry.*

74. "In the ANIMAL organism the VITAL FORCE EXHIBITS ITSELF AS IN THE PLANT, in the form of GROWTH, and AS THE MEANS OF RESISTANCE TO EXTERNAL AGENCIES." —IBID.

75. "If we assume that ALL THE PHENOMENA exhibited by the organism of PLANTS and animals are to be ascribed to A PECULIAR CAUSE, different in its manifestations from ALL OTHER CAUSES which produce MOTION OF CHANGE OF CONDITION; if, therefore, we regard THE VITAL FORCE as an INDEPENDENT FORCE (no. 3), then, in the phenomena of organic life, as in all other phenomena ascribed to the action of forces, we have the *statics*, that is, the state of equilibrium determined by a RESISTANCE, and the DYNAMICS OF THE VITAL FORCE"!—IBID.

76. "Vegetables produce in their organism THE BLOOD OF ALL ANIMALS."—LIEBIG, *ibid.*

To occupy space, nos. 26½ and 27 are contrasted with nos. 25 and 26 in the same column. And so with 5½, 23½. But here is more in the more appropriate place, upon this fundamental point. Thus:

77. "When it is considered, that sea-water contains less than

CHEMICAL DOCTRINES.

ERRONEOUS."—LIEBIG'S *Organic Chemistry*, &c.]

29. "The most decisive experiments of physiologists have shown that the process of CHYMIFICATION *is independent of the* vital force; that it takes place in virtue of a PURELY CHEMICAL action, EXACTLY SIMILAR to those processes of DECOMPOSITION or transformation which are known as PUTREFACTION, FERMENTATION, or DECAY."—LIEBIG'S *Animal Chemistry*.

"Those remarkable phenomena, FERMENTATION, PUTREFACTION, and DECAY, are THE PROCESSES of DECOMPOSITION, and their ultimate results are to RECONVERT the elements of organic bodies into that state in which they exist before they participate in the processes of life."—LIEBIG'S *Lectures for* 1844.

30. "The second part of the work will treat of the CHEMICAL processes which effect the COMPLETE DESTRUCTION of plants and animals AFTER DEATH, such as the *peculiar* modes of decomposition usually described as *fermentation*, *putrefaction*. and *decay*."—LIE-

VITAL DOCTRINES.

$\frac{1}{1000000}$ of its own weight of iodine, and that all combinations of iodine with the metallic bases of alkalies are highly soluble in water, *some provision must necessarily be supposed to exist* IN THE ORGANIZATION of sea-weed and the different kinds of force by which they are enabled, DURING THEIR LIFE, TO EXTRACT IODINE in the form of a soluble salt from sea-water, and to ASSIMILATE IT IN SUCH A MANNER that it is not again restored to the surrounding medium. These plants are COLLECTORS OF IODINE, JUST AS LAND PLANTS ARE OF ALKALIES; and they yield us this element IN QUANTITIES such as we could not otherwise obtain from the water without the evaporation of WHOLE SEAS."—LIEBIG'S *Organic Chemistry applied to Physiology*, &c.

78. "The EQUILIBRIUM in the chemical attractions of the constituents of food is disturbed BY THE VITAL PRINCIPLE;" and "THE UNION of its ELEMENTS, so as to produce *new combinations* and *forms*, indicates *a peculiar mode of attraction*, and the existence of A POWER DISTINCT FROM ALL OTHER POWERS OF NATURE, namely, the VITAL PRINCIPLE."—LIEBIG'S *Organic Chemistry applied to Physiology*, &c.

79. "The VITAL FORCE CAUSES A DECOMPOSITION of the constituents of food, and destroys the force of attraction which is continually exerted between their molecules. It alters the direction of the CHEMICAL FORCES in such wise, that the ELEMENTS of the constituents of the food arrange themselves in another form, and combine to produce *new compounds*. It FORCES the *new compounds* to assume forms ALTOGETHER DIFFERENT from those which are the result of the attraction of cohesion when acting free-

CHEMICAL DOCTRINES.

BIG's *Organic Chemistry applied to Physiology*, &c.

31. "In the SAME WAY as MUSCULAR FIBRE, when separated from the body, communicates the state of decomposition existing in its elements to the peroxide of hydrogen, so a certain product, arising by means of the vital process, and *by consequence of the transposition of the elements of parts of the stomach and of the other digestive organs* [!] while its own metamorphosis is accomplished in the stomach, ACTS ON THE FOOD. The insoluble matters are DIGESTED" !—Liebig's *Animal Chemistry*.

32. "Is it truly VITALITY, which generates SUGAR IN THE GERM for the nutrition of young plants, or which gives to the STOMACH the power to dissolve and to prepare for assimilation all the matter introduced into it? A DECOCTION OF MALT possesses as little power to reproduce itself, as the *stomach* of a DEAD CALF. Both are, unquestionably, destitute of life. But, when starch is introduced into a decoction of malt, it changes, first into a gummy matter, and lastly into sugar. Hard-boiled albumen, and muscular fibre, can be dissolved in a decoction of a calf's stomach, to which a few drops of muriatic acid have been added, PRECISELY *as in the stomach itself*."—Liebig's *Organic Chemistry*, &c. (no. 11).

33. "*All substances* which can arrest the phenomena of *fermentation* and *putrefaction* in liquids, also *arrest digestion* when taken into the stomach" !—Liebig's *Animal Chemistry*.

34. "In the natural state of the digestive process, the food *only undergoes a change in its state of cohesion*, becoming fluid without any other change of properties."—Liebig's *Animal Chemistry*.

VITAL DOCTRINES.

ly, that is, without resistance."—Liebig's *Animal Chemistry*.

80. "It is well known that in many graminivorous animals, where the digestive organs have been overloaded with fresh juicy vegetables, these substances UNDERGO IN THE STOMACH THE SAME DECOMPOSITION as they would at the same temperature OUT OF THE BODY. They pass into FERMENTATION and PUTREFACTION, whereby so great a quantity of CARBONIC ACID GAS and of INFLAMMABLE GAS IS GENERATED, that these organs are enormously distended, and sometimes even to BURSTING."—Liebig's *Animal Chemistry*.

81. "The VITAL FORCE appears as a MOVING FORCE or cause of motion, when it OVERCOMES the CHEMICAL FORCES, cohesion and AFFINITY, which act between the constituents of food, and when IT CHANGES the position or place in which their ELEMENTS occur. The VITAL FORCE is manifested as A CAUSE OF MOTION in OVERCOMING THE CHEMICAL ATTRACTION of the constituents of food, and is, farther, THE CAUSE WHICH COMPELS them to combine in a new arrangement, and to assume new forms."—Liebig's *Animal Chemistry*.

82. "It will be shown in the second part of this work, that all plants and vegetable structures undergo two processes of decomposition AFTER DEATH. One of these is named FERMENTATION, the other DECAY OR PUTREFACTION."—Liebig's *Organic Chemistry applied to Physiology*, &c., (§ 349, *c*, *e*).

83. "The individual organs, such as the STOMACH, cause all the organic substances conveyed to them, which are capable of transformation, to assume NEW FORMS. The STOMACH *compels* the ELE-

CHEMICAL DOCTRINES.

35. Although "the process of CHYMIFICATION IS INDEPENDENT of the *vital force*, and takes place in virtue of a *purely chemical action*, EXACTLY *similar* to those processes of decomposition which are known as PUTREFACTION, FERMENTATION, or DECAY;" nevertheless, "INORGANIC compounds DIFFER from ORGANIC *in as great a degree* as in their SIMPLICITY *of constitution*."—LIEBIG'S *Animal Chemistry*, and *Organic Chemistry*.

36. "THE POWER of elements to unite together, and to form peculiar compounds which are generated in animals and vegetables, is CHEMICAL AFFINITY." — LIEBIG'S *Organic Chemistry applied to Physiology*, &c.

37. "We should not permit ourselves to be withheld, by the idea of a VITAL PRINCIPLE, from considering in a CHEMICAL POINT OF VIEW, the process of TRANSFORMATION OF THE FOOD, and its ASSIMILATION by the VARIOUS ORGANS. This is the more necessary, as the views hitherto held have produced no results, and are quite incapable of useful application."—LIEBIG'S *Organic Chemistry applied*, &c.

38. "We know that an organized body cannot generate substances, but only change the mode of their combinations, and that its SUSTENANCE and REPRODUCTION *depend* upon the CHEMICAL transformation of the matters which are employed as its nutriment, and which contain its own constituent

VITAL DOCTRINES.

MENTS of these substances to unite into a COMPOUND *fitted* for the formation of the blood."—LIEBIG'S *Organic Chemistry*, &c.

84. "The FIRST substance capable of affording nutriment to animals is the LAST product of the CREATIVE ENERGY of vegetables." —LIEBIG'S *Animal Chemistry*.

85. "The special characters of food, that is, of substances fitted for assimilation, are ABSENCE OF ACTIVE CHEMICAL PROPERTIES, and the capability of yielding to transformations." — LIEBIG'S *Organic Chemistry applied to Physiology*, &c.

86. "*All experience proves* that there is in the organism only *one* source of *physical* power; and this source is the *conversion of living parts into lifeless*, AMORPHOUS COMPOUNDS." — LIEBIG'S *Animal Chemistry*.

86½. "It is only with the COMMENCEMENT of *chemical* action that the separation of a part of an organ in the form of *lifeless* compounds *begins*."—LIEBIG'S *Animal Chemistry*.

87. "When a chemical compound of simple constitution is introduced into the stomach, its CHEMICAL ACTION is, of course, OPPOSED BY THE VITAL PRINCIPLE. The results produced depend upon the strength of their respective actions. Either an *equilibrium* of BOTH POWERS is attained, a change being effected without the *destruction of the vital principle*; in which case a MEDICINAL EFFECT is occasioned. Or, the acting body YIELDS TO THE SUPERIOR FORCE OF VITALITY, that is, IT IS DIGESTED. Or, lastly, the CHEMICAL ACTION obtains the ascendency and ACTS AS A POISON." — LIEBIG'S *Organic Chemistry applied to Physiology*, &c.

87½. "The VITAL POWER in veg-

CHEMICAL DOCTRINES.

elements. Whatever we regard as the cause of these transformations, the act of transformation is a PURELY CHEMICAL PROCESS. It will be shown, when considering the processes of *fermentation* and *putrefaction*, that any disturbance of the mutual attraction subsisting between the elements of a body gives rise to a transformation."—LIEBIG'S *Organic Chemistry*, &c.

9. "By CHEMICAL AGENCY we can produce the CONSTITUENTS of muscular fibre, skin, and hair"! "We are able to form, in our laboratories, formic acid and urea, &c., all products, IT IS SAID, of the VITAL PRINCIPLE. We see, therefore, that this MYSTERIOUS VITAL PRINCIPLE CAN BE REPLACED BY THE CHEMICAL FORCES"!!—LIEBIG'S *Organic Chemistry* (no. 16, 51, § 53).

40. "The INFLUENCE of poisons and of remedial agents on the living animal body evidently shows that the CHEMICAL decompositions and combinations in the body, WHICH MANIFEST THEMSELVES IN THE PHENOMENA OF VITALITY, may be increased in intensity by CHEMICAL FORCES of an analogous character, and retarded or PUT AN END TO by THOSE of opposite character;

VITAL DOCTRINES.

etables accomplishes the TRANSFORMATION of MINERAL substances into an organism endowed with life." — LIEBIG'S *Animal Chemistry*.

$87\frac{3}{4}$. "The cause of *waste* of matter is the chemical action of oxygen. This waste of matter occurs in consequence of the absorption of oxygen into the substances of living parts. This absorption of oxygen *occurs only* when the resistance which the *vital force of living parts* opposes to the chemical action of the oxygen is weaker than that chemical action."—LIEBIG'S *Animal Chemistry* (nos. 3, 4, 7, 8, 11, $86\frac{1}{2}$).

88. "The CONSTITUENTS of VEGETABLE and ANIMAL substances HAVING BEEN FORMED *under* THE GUIDANCE AND POWER of the VITAL PRINCIPLE, *it is this principle* which *determines* the direction of their molecular attraction." "*The vital principle* ALONE is capable of restoring the original order and manner of the molecular arrangement in the smallest particles of albumen."—LIEBIG'S *Lectures for* 1844 (§ 48–50).

"We cannot expect from organic chemistry the SYNTHETIC proof of the accuracy of the views entertained, because EVERY THING in the organism goes on UNDER THE INFLUENCE of the VITAL FORCE, AN IMMATERIAL AGENT [!] which the chemist CANNOT EMPLOY at will." —LIEBIG'S *Animal Chemistry*.

89. "From the theory of disease developed in the preceding pages, it follows, obviously, that a *diseased* condition once established, in any part of the body, CANNOT be made to disappear by the CHEMICAL ACTION of a remedy."—LIEBIG'S *Animal Chemistry*.

90. "THE VITAL FORCE IS SUBJECT TO THE ACTION OF A BLISTER.' —*Ibid.*

CHEMICAL DOCTRINES.

and that we are enabled to exercise an influence on every part of an organ by means of substances possessing a well-defined CHEMICAL ACTION."—LIEBIG'S *Animal Chemistry* (mottoes *a–e*).

41. "It is singular that we find medicinal agencies ALL DEPENDENT ON CERTAIN MATTERS, which differ in composition [*moral emotions, heat, cold, change of air, exercise ?*]; and if, by the introduction of a substance, certain abnormal conditions are rendered normal, *it will be impossible* to reject the opinion, that this phenomenon depends on a CHANGE IN THE COMPOSITION of the constituents of the diseased organism [no. 5], a change in which the ELEMENTS OF THE REMEDY TAKE A SHARE SIMILAR TO THAT WHICH THE VEGETABLE ELEMENTS OF FOOD have taken in the formation of *fat, of membranes, of the saliva, of the seminal fluid*, &c. [!] Their carbon, hydrogen, or nitrogen, or whatever else belongs to their composition, are derived from the vegetable organism; and, after all, *the action and effects* of quinine, morphia, and the vegetable poisons in general, *are no hypotheses" !* — LIEBIG'S *Animal Chemistry* (§ 18, and motto *d*).

42. "With respect to the ACTION of quinine, or the alkaloids of opium, &c., physiologists and pathologists entertain no doubt that it is exerted chiefly on the brain and nerves. If we reflect that this action is exerted by substances which are material, tangible, and ponderable; that they disappear in the organism; that a double dose acts more powerfully than a single one; that, after a time, a fresh dose must be given if we wish to produce the action a second time; all *these considerations*, viewed *chemically*, [!] permit only one form of explanation; the supposition,

VITAL DOCTRINES.

91. "The VITAL FORCE in a living animal tissue appears as A CAUSE of growth in the mass, and of RESISTANCE to those external agencies which tend TO ALTER the form, structure, and COMPOSITION of the SUBSTANCE of the tissue in which the *vital energy resides*."—LIEBIG'S *Animal Chemistry*.

92. "The *slightest action* of a *chemical* agent upon the blood exercises an INJURIOUS INFLUENCE. Even the momentary contact with the air in the lungs, although effected through the medium of cells and membranes, alters the color and other qualities of the blood." —LIEBIG'S *Organic Chemistry applied to Physiology*, &c.

93. "Every substance may be considered as NUTRIMENT, which loses its former properties when acted on by the VITAL PRINCIPLE, and does not exercise a *chemical* action upon the living organ. ANOTHER CLASS of bodies change the direction, the strength, and intensity of the *resisting vital principle*, and THUS exert a modifying influence upon the FUNCTIONS of its organs. *These* are MEDICAMENTS. A THIRD CLASS of compounds are called POISONS, WHEN they possess the property of UNITING WITH ORGANS or with their component parts, and *when their power of effecting this is stronger than the resistance offered by the vital principle*."—LIEBIG'S *Organic Chemistry*, &c.

CHEMICAL DOCTRINES.

namely, that these compounds, by means of their elements, take a share *in the* FORMATION *of new* or the TRANSFORMATION of EXISTING BRAIN AND NERVOUS MATTER" ! !—LIEBIG'S *Animal Chemistry.*

43. "Owing to its volatility and the ease with which its vapor permeates animal tissues, ALCOHOL CAN SPREAD THROUGHOUT THE BODY IN ALL DIRECTIONS" !—LIEBIG'S *Animal Chemistry* (§ 350½, *n*).

44. "It is impossible to mistake the *modus operandi* of putrefied sausages, or muscle, urine, cheese, cerebral substance, and other matters, in a state of *putrefaction.*" "It is obvious that they COMMUNICATE THEIR OWN STATE OF PUTREFACTION TO THE SOUND BLOOD, from which they were produced, *exactly in the same manner as gluten* in a state of decay or putrefaction *causes a similar transformation in a solution of sugar*" *!*

45. "The MODE OF ACTION of a *morbid virus* exhibits such a STRONG SIMILARITY TO THE ACTION OF YEAST upon liquids containing sugar and gluten, that the two processes have been long since *compared* to one another, although merely for the purpose of *illustration.* [They have often been represented as *identical.*] But, when the phenomena attending the action of each respectively are considered more closely, it will in REALITY be seen that their influence DEPENDS UPON THE SAME CAUSE." "*Ordinary yeast*, and the *virus of human small-pox*, effect a violent tumultuous transformation, the former in vegetable juices, the latter *in the blood*" *!* "The action of the *virus of cow-pox* is analogous to that of *low yeast* [*!*] It communicates *its own state of decomposition* to A MATTER in the blood, and from a SECOND MATTER is itself re-

VITAL DOCTRINES.

94. "According to *all the observations* hitherto made, *neither* the expired air, nor the perspiration, nor the urine, *contains* ANY TRACE OF ALCOHOL, after indulgence in spirituous liquors."—LIEBIG'S *Animal Chemistry.*

95. "The VIVIFYING agency of the BLOOD must ever continue to be the most important condition in the *restoration* of a disturbed EQUILIBRIUM, and the blood must, therefore, be considered and constantly kept in view, as the ultimate and MOST POWERFUL CAUSE OF LASTING VITAL RESISTANCE, as well in the DISEASRD as in the UNAFFECTED parts of the body."—LIEBIG'S *Animal Chemistry.*

Nevertheless,

"No other component part of the organism *can be compared* to the BLOOD, in respect of the FEEBLE RESISTANCE which it offers to exterior influences." "The chemical force and the vital principle hold each other in such perfect EQUILIBRIUM, that every disturbance, *however trifling*, or from WHATEVER CAUSE it may proceed, EFFECTS A CHANGE IN THE BLOOD."—LIEBIG'S *Organic Chemistry applied*, &c.

But, again, nevertheless,

"It is obvious, moreover, that in all diseases where the formation of contagious matter and of exanthemata is accompanied by fever, TWO diseased conditions *simultaneously* exist, and two processes are simultaneously completed; and that the BLOOD, as it were, BY REACTION, that is, fever, BECOMES A MEANS OF CURE."—LIEBIG'S *Animal Chemistry*

CHEMICAL DOCTRINES.

generated" ! "The *susceptibility* of infection by the virus of human small-pox MUST CEASE *after vaccination*, FOR THE SUBSTANCE to the presence of which this susceptibility is owing HAS BEEN REMOVED from the body by a peculiar process of DECOMPOSITION artificially excited" ! "COLD MEAT is always in a state of decomposition. It is possible that THIS STATE may be communicated TO THE SYSTEM of a FEEBLE individual, and may be one of the SOURCES OF CONSUMPTION" ! !—LIEBIG'S *Organic Chemistry applied to Physiology*, &c. (§ 821).

"*From the unequal degree of the conducting power* in the nerves, we must deduce those conditions which are termed paralysis, syncope, and spasm"!—LIEBIG'S *Animal Chemistry*.

46. "IN ALL CHRONIC DISEASES, DEATH IS PRODUCED BY THE SAME CAUSE, NAMELY, THE CHEMICAL ACTION OF THE ATMOSPHERE."

"THE TRUE CAUSE OF DEATH IS THE RESPIRATORY PROCESS, [!] that is, the chemical action of the atmosphere." — LIEBIG'S *Animal Chemistry* (§ 674–676).

VITAL DOCTRINES.

96. "It is only by a just application of its principle that any theory can produce really beneficial results."—LIEBIG'S *Animal Chemistry*.

97. "We can have no very high idea of experiments made by gentlemen (*chemists*, with reference to digestion) who, for want of anatomical knowledge, have not been able to pursue their reasoning even beyond the simple experiment itself." — JOHN HUNTER'S *Observations on Digestion*.

*** The quotations from "Liebig's Organic Chemistry applied to Physiology" are derived from Mr. Playfair's edition, London, 1840; those from "Liebig's Animal Chemistry" are taken from Professor Gregory's edition, reprinted New York, 1842. The italics and capitals are mine.

350¼. To carry out the full object of the foregoing section, I shall devote another to a farther exhibition of the pathological and therapeutical doctrines which have been deduced by the author of the "new era in medicine" from his chemical and physiological elements, as their resulting compounds. This more extended display of theoretical and practical doctrines, as they came to us from the laboratory, will reflect a broad light upon the chemical hypotheses of digestion, nutrition, &c., as set forth in the preceding section, and show us, also, the extent of the probabilities which relate to the analysis of food and of the conclusions which are predicated of that analysis (§ 18, 409, 676 *b*), and, in brief, enable us to comprehend the nature and amount of the service which organic chemistry has rendered to the science of medicine.

This otherwise isolated subject will be farther interesting, as I shall embrace in the quotations the whole science of medicine as founded

on chemistry and physics, and thus place in contrast the systems of the two rival schools, and enable the reader to adjust their relative merits. To do this work of consigning chemistry to its legitimate pursuits the more effectually, I shall also expose, in an appropriate place, the chemical doctrine of animal heat in the language of him who is supposed to have settled the philosophy of that subject (§ 433–450, 676).

And before proceeding to a farther exposition of the vital and chemical doctrines of digestion, I shall, in consideration of the general surrender of this subject to the laboratory of the chemist, exhibit the corroborating testimony of the distinguished Mülder, that physiology and medicine have nothing to hope from observations conducted out of the living body (§ 350, nos. 48, 49).

By the method now contemplated, obstacles may be removed, and the reader better disposed to consider maturely the grounds upon which I have placed the vital doctrine of digestion, and come the more willingly to the conclusion that none are so imperfectly qualified to interpret the properties and laws of organic beings as they who can reason alone from the slender and deceptive analogies supplied by inorganic nature, and artificial expedients.

It is certainly remarkable that this systematic exposure should be necessary at the middle of the nineteenth century, when arts and all other sciences, though more so the arts, are making a steady, sometimes an astonishing progress.

I may be mistaken in the importance which I have attributed to the innovations which have been made by organic chemistry upon medical philosophy. I know that I am but feebly sustained by others in my conclusions; though now and then a blaze of mind assures me that deep volcanic action is in smothered progress (§ 376$\frac{3}{4}$).

350$\frac{1}{2}$, *a.* We have, then, from the authorized works of Liebig (§ 349, *d*), in the first place, the following inductions, in the order of their occurrence, of

Pathological Principles, or "Theory of Disease" (350, no. 59).

"Every substance or matter, every chemical or mechanical agency, which changes or disturbs the restoration of the equilibrium between the manifestations of the causes of waste and supply, in such a way as to add its action to the causes of waste, is called a cause of disease. Disease occurs when the sum of the *vital force*, which tends to neutralize all *causes of disturbance*, in other words, when the resistance offered by the vital force, is weaker than *the acting cause of disturbance;*"—with the reservation, nevertheless, that "*the cause of disturbance, or chemical force and the vital force, are one and identical.*"

350$\frac{1}{2}$, *b.* "Death is the condition in which all resistance on the part of the vital force entirely ceases. So long as this condition is not established, the living tissues continue to offer resistance."

350$\frac{1}{2}$, *c.* "To the observer, the action of a cause of disease exhibits itself in the disturbance of the proportion between waste and supply which is proper to each period of life. In medicine, every abnormal condition of supply or of waste, in all parts, or in a single part of the body, is called *disease.*"

350$\frac{1}{2}$, *d.* "It is evident that one and the same cause of disease will produce in the organism very different effects, according to the period

of life. A cause of disease which strengthens the causes of supply, either directly or indirectly, by weakening the action of the causes of waste, destroys, in the child and in the adult, the relative normal state of health; while in old age it merely brings the waste and supply into equilibrium.

350½, *e.* " A child, *lightly clothed*, can bear cooling by a low external temperature without injury to health. [!] The force available for mechanical purposes and the temperature of its body increase with the change of matter which follows the cooling; while a high temperature, which impedes the change of matter, is followed by disease."

350½, *f.* " A deficiency of resistance, in a living part, to the causes of waste, is, obviously, a deficiency of resistance to the action of the oxygen of the atmosphere.

350½, *g.* " When, from any cause whatever, this resistance diminishes in a living part, the change of matter increases in an equal degree.

350½, *h.* " Now, since the phenomena of motion in the animal body are dependent on the change of matter, the increase of the change of matter in any part is followed by an increase of all motions. According to the conducting power of the nerves, the available force is carried away by the nerves of involuntary motion alone, or by all the nerves together. [!]

350½, *i.* "Consequently, if, in consequence of a diseased transformation of living tissues, a greater amount of force be generated than is required for the production of the normal motions, it is seen in an acceleration of all or some of the involuntary motions, as well as in a higher temperature of the diseased part. This condition is called *fever.*

350½, *j.* " When a great excess of force is produced by change of matter, the force, since it can only be consumed by motion, extends itself to the apparatus of *voluntary motion.* This state is called *a febrile paroxysm.*

350½, *k.* " In consequence of the acceleration of the circulation in the state of fever, a greater amount of arterial blood, and, consequently, of oxygen, is conveyed to the diseased part, as well as to all other parts; and, if the active force in the healthy parts continue uniform, the whole action of the excess of oxygen must be exerted on the diseased part alone (§ 350, no. 10).

350½, *l.* " According as a single organ, or a system of organs, is affected, *the change of matter* extends to one part alone, or to the whole affected system.

350½, *m.* "Should there be formed, in the diseased parts, in consequence of *the change of matter*, from the elements of the blood or of the tissue, NEW PRODUCTS, which the neighboring parts cannot employ for their own vital functions; should the surrounding parts, moreover, be unable to convey these products to other parts, where they may undergo transformation, then *these new products* will suffer, at the place where they have been formed, *a process of decomposition analogous to fermentation or putrefaction*" *!*

350½, *n.* " If we consider the fatal accidents which so frequently occur in wine countries from the drinking of what is called featherwhite wine, we can no longer doubt that GASES OF EVERY KIND, *whether soluble or insoluble in water, possess the property of permeating ani-*

mal tissues, as water penetrates unsized paper [!] (§ 350, no. 24). This poisonous wine is wine still in a state of fermentation, which is increased by the heat of the stomach. The carbonic acid which is disengaged penetrates through the parietes of the stomach, [!!] through the diaphragm, [!!!] and through all the intervening membranes, [!!!!] into the air-cells of the lungs, [!!!!!] out of which it displaces the atmospherical air. [!!!!!!] The patient dies with all the symptoms of asphyxia caused by an irrespirable gas, [!] and the surest proof of the presence of carbonic acid in the lungs is the fact, that the inhalation of ammonia, which combines with it, is recognized as the best antidote against this kind of poisoning"!

"No doubt a part of these gases may ENTER THE VENOUS CIRCULATION through the absorbent and lymphatic vessels, and thus reach the lungs, where they are exhaled; [!] but the presence of membranes offers not the SLIGHTEST OBSTACLE to their passing directly into the cavity of the chest"! (§ 349 *d*, 449 *b*, 827 *h*).

350½, *o*. "It is known that in cases of *wounds of the lungs* a peculiar condition is produced, in which, by the act of inspiration, not only oxygen but atmospherical air, with its whole amount of nitrogen, penetrates into the cells of the lungs. This air is carried by the circulation [!] to every part of the body, [!!] so that EVERY PART is inflated or puffed up with the air, as with water in dropsy. [!] This state ceases, without pain, as soon as the entrance of the air through the wound is stopped."

350½, *p*. "The frightful effects of prussic acid, which, when inspired, puts a stop to all the phenomena of motion in a few seconds, are explained in a natural manner by the well-known action of this compound on those of iron, when alkalies are present"!! (§ 494 *d*, 3, 827 *d*, 904 *b*).—LIEBIG'S *Animal Chemistry*.

350½, *q*. The foregoing doctrines, with the humoral philosophy as quoted in § 350, nos. 40–45, make up the whole science of pathology as delivered to us from the laboratory; and such, too, are the doctrines which are hailed as the foundation of "a new and the greatest era of medicine." There can be no doubt, however, that deliberate investigation will satisfy every mind that they are unintelligible, impracticable, absurd; and, consequently, that the whole pretended system of physiology from which they are deduced, is equally unworthy the dignity of reason.

350⅔, *a*. I shall now employ the same authorized chemist (§ 349, *d*) to give the last blow to his baseless fabric, and to scatter its fragments beyond the reach of idolatry itself. This will be done by setting forth, in the language of the author, his deductions from the physiological and pathological doctrines of the laboratory, as to

The Chemical Treatment of Disease (§ 350, no. 59).

"The accelerated change of matter, and the elevated temperature in diseased parts, show that the resistance offered by the vital force to the action of oxygen is feebler than in the healthy state. But this resistance only ceases entirely when death takes place (nos. 1 and 2). By the artificial diminution of resistance in another part (as by blisters, sinapisms, or setons), the resistance in the diseased organ is not, indeed, directly strengthened; but the chemical action, the cause of the change of matter, is diminished in the diseased part, *being direct-*

ed to another part, where the physician has succeeded in producing a still more feeble resistance to the change of matter, TO THE ACTION OF OXYGEN.

350$\frac{1}{3}$, *b.* "A complete cure of the original disease occurs, when external action and resistance, in the diseased part, are brought into equilibrium. Health, and the restoration of the diseased tissue to its original condition, follow, when we are able so far to weaken the disturbing action of oxygen, by any means, that it becomes inferior to the resistance offered by the vital force, which, although enfeebled, has never ceased to act; for this proportion between these causes of change is the uniform and necessary condition of increase of mass in the living organism."

350$\frac{2}{3}$, *c.* "In cases of a different kind, where artificial external disturbance produces no effect, the physician adopts other indirect methods to exalt the resistance offered by the vital force. He diminishes, by blood-letting, the number of the carriers of oxygen (the globules), and, by this means, the conditions of change of matter; he excludes from the food all such matters as are capable of conversion into blood, &c.

350$\frac{2}{3}$, *d.* "If he succeed, by these means, in diminishing the action of oxygen in the blood on the diseased part, so far that the vital force of the latter, its resistance, in the smallest degree, overcomes the chemical action; and if he accomplish this without arresting the functions of other organs, then restoration to health is certain. [!]

350$\frac{2}{3}$, *e.* "Practical medicine, in many diseases, makes use of *cold* in a highly rational manner, as a means of exalting and accelerating, in an unwonted degree, the CHANGES OF MATTER. This occurs especially in certain morbid conditions, *in the substance of the centre of the apparatus of motion;* when a glowing heat and a rapid current of blood toward the head point out an abnormal METAMORPHOSIS OF THE BRAIN [!] (350, motto *i*, nos. 3, 5). When this condition continues beyond a certain time, experience teaches that all motions in the body cease. [!] If the change of matter be chiefly confined to the brain, then the change of matter, the generation of force, diminishes in all other parts. [!] The *metamorphosis* which decides the issue of the disease is limited to a short period. We must not forget that the *ice melts* and absorbs heat from the diseased part; that if the ice be removed before the completion of the *metamorphosis*, the temperature again rises; that *far more heat is removed from the head than if we were to surround the head with a bad conductor of heat.* There has obviously been liberated, in an equal time, a far larger amount of heat than in the state of health. [That is to say, such is the pathology of cerebral inflammation, such the remedy, and such its modus operandi.]

350$\frac{2}{3}$, *f.* "The self-regulating steam-engines, in which, to produce a uniform motion, the human intellect has shown the most admirable acuteness and sagacity, furnish no unapt image of what occurs in the animal body.

"Every one knows, that in the tube which conveys the steam to the cylinder where the piston-rod is to be raised, a stop-cock of peculiar construction is placed, through which all the steam must pass. By an arrangement connected with the regulating wheel, this stop-cock opens when the wheel moves slower, and closes more or less completely

when the wheel moves faster than is required for a uniform motion. When it opens, more steam is admitted (more force), and the motion of the machine is accelerated. When it shuts, the steam is more or less cut off, the force acting on the piston-rod diminishes, the tension of the steam increases, and this tension is accumulated for subsequent use. The tension of the vapor, or THE FORCE, so to speak, is PRODUCED BY CHANGE OF MATTER, *by the combustion of coals in the fire-place.* The force increases (the amount of steam generated and its tension increase) with the temperature in the fire-place, which depends on the supply of coals and of air (§ 433, &c.). There are in these engines other arrangements, all intended for regulation. When the tension of steam in the boiler rises beyond a certain point, the passages for admission of air close themselves; the combustion is retarded, the supply of force (steam) is diminished. When the engine goes slower, more steam is admitted to the cylinder, its tension diminishes, the air-passages are opened, and the cause of disengagement of heat, or production of force, increases. Another arrangement supplies the fire-place incessantly with coals in proportion as they are wanted.

"If we now lower the temperature at any part of the boiler, the tension within is diminished. This is immediately seen in the regulators of force, which act precisely as if we had removed from the boiler a certain quantity of steam, or force. The regulator and the air-passages open, and the machine supplies itself with more coals.

"*The body, in regard to the production of heat and force, acts just like one of these machines.* With the lowering of the external temperature, the respirations become deeper and more frequent; oxygen is supplied in greater quantity and of greater density, the change of matter is increased, and more food must be supplied, if the temperature of the body is to remain unchanged."—LIEBIG's *Animal Chemistry.*

Here ends the science of *therapeutics*, as founded upon the preceding doctrines in physiology and pathology; and as the whole system is comprehended within the limits of the last three pages, the reader will readily contrast its brevity with the labors of the past, and will not fail to discover in this time-saving, thought-saving attainment of medicine, as well as in the impenetrability of the system itself, and the unequaled confidence with which it is set forth, the main causes of its success.

I shall now proceed, as proposed in § 350¼, to demonstrate by the farther showing of chemistry itself, that physiology and medicine have little to hope from the laboratory of the chemist.

350¾, *a.* Of the school of pure chemistry, and of an authority approaching to Liebig, is the distinguished Professor Mülder; less inconsistent than Liebig, but compelled to admit the existence of peculiar forces in living beings, yet positively denying them. He advocates, after the manner of Prichard, Carpenter, Fletcher, &c., the existence of all the properties of living beings in the elements of matter, which conducts him, like others, to the belief in Equivocal Generation; adopts the *Catalytic theory* of Berzelius, in which he differs fundamentally from Liebig (§ 409, *j*); reasons, after the usual manner of the physical philosophers of life, from the results of inorganic processes, and overlooks entirely, except by admission of their existence, all the unique phenomena of living beings, and, perhaps, more than

any author of merit, is guided in his conclusions as to the processes and results of organic beings by the fallacious analogies which are studiously sought in the inorganic world. The whole system of vital philosophy, as taught by this distinguished Professor of *Chemistry*, may be so briefly set forth in extracts from his work on "The Chemistry of Vegetable and Animal Physiology," and they convey so forcibly the conjectural nature and worthlessness of chemical physiology, that the selection will contribute its important part toward the final expulsion of chemistry from the rich and fascinating domain of organic nature. The quotations will be made in the order of their occurrence in the work; and we learn from the first the author's opinion of *force*, which corresponds with my own as employed in the *Commentaries*, and as defended in my *Examination of Reviews*. Thus:

350¾, *b*. "It is a matter of indifference whether we conceive that the *forces slumber* in two substances, and are brought into operation by contact; or that these forces were present in the two bodies in an *active* state, *previous* to the contact, but produced the phenomena of combination only *during* the contact. The mode of considering this point is almost a matter of indifference; but we must always bear in mind that it is a *power*, a *force* which is exerted by the one, and which acts upon the other."—MÜLDER.

350¾, *c*. The next quotation is preliminary to the total denial of the Principle of Life, and of all the properties in living beings excepting such as are active or "*slumbering*" in the elements of matter. Here, too, appears the fallacy of analogies derived from the laboratory of the chemist. Thus:

"Adhering to what we observe and know with certainty, we calculate that every elementary body is endowed with a great many specific properties, which, to a large extent, are dependent on the same principle that causes their combination, and thus on the proportion and character of the *chemical tendency*. If we adopt this idea, we have the advantage of seeing somewhat of VITALITY IN DEAD MATTER. [!] IT IS AN IDEA DERIVED from the endless series of phenomena which are observed IN THE LABORATORY, in daily occurrences, and in nature at large" (§ 175, *d*).—MÜLDER.

350¾, *d*. After the usual disquisition upon the "catalytic action" of platinum and other inorganic substances, we come next to the same application of *catalysis*, in connection with the ordinary laws of chemical affinity, to the interpretation of organic processes and results, as I have examined in the "*Commentaries*" (vol. i., p. 55–78). It comprehends Mülder's whole theory of life, and is a good specimen of the author's analogical reasoning. Thus:

"Platinum possesses chemical tendency in a high degree; but it is of such a kind, that it does not react upon the platinum. Hence it may be inferred, that we have good reason for distinguishing by a peculiar name such actions as proceed from certain substances without reacting upon themselves; and we have to acknowledge that to the introduction, by Berzelius, of the peculiar term *catalysis*, we are indebted for a more correct idea of the nature of ordinary chemical action.

"What is called the *nascent state* of substances is that condition of the *elements* in which they exhibit both *analytic* and *catalytic* phenomena; in which, being free and unconstrained, not rendered powerless

either by being agglomerated into masses, or by combination into compounds, they show themselves in their proper *chemical* condition; that is, an active one, in which they can operate upon others, excite a slumbering energy, and cause combinations and decompositions, in which they themselves may either participate or not. This *nascent* state is the *real chemical* state of bodies. In that state both the elements and compounds exhibit themselves in their true character. In he organic kingdom the greater number of substances are actually in that condition; and to *this nascent state* we ought to ascribe the *numerous peculiar* phenomena apparent in *organic* substances" (§ 409).—MÜLDER.

350¾, *e*. The next quotation sets forth the whole practical application of the foregoing doctrines, and is a fine example of the chemical reduction of organic nature to the condition of dead matter, and one of the best summary exhibitions of chemistry in all its pretended relations to living beings. It begins with the caption

"*Disturbance of Chemical Equilibrium.*"

"It is a property of the *chemical forces*, when active in any substance, to excite analogous forces in others. We notice this especially in *organic nature*, and it is nowhere more strikingly illustrated than in the NUTRITION of animals. Blood, a HOMOGENEOUS fluid, circulates through very different parts of the body (§ 42). In the muscles it sustains muscles, in the liver it supplies the component parts of the liver, and from it the gall is there secreted; in the kidneys it maintains their various parts, and secretes the urine, &c. *None of these secretions appear in the blood with their peculiar qualities; of some of them not even a trace is found.* But the four organic elements of the whole are to be found in protein and its combinations, in the coloring matter of the blood, &c. The elements of protein might, no doubt, be transposed in the liver, &c., by means of catalysis, and so the component parts of the liver and gall be produced from it. It would only be necessary, then, that the constituent parts of the liver should be put into contact with the component parts of the blood, and the forces of affinity resident in the substance of the liver would not require to influence those in the protein, or to produce any chemical alteration in its component parts.

"Other causes, however, ought undoubtedly to be considered. For instance, a change of its component parts takes place in the liver itself, and, from the first, chemical forces actively operate therein For the continual change of its component parts is a chief characteristic of every living organic substance. These forces may disturb the chemical equilibrium of other substances, and cause the formation of new products. If the constituents of the blood—the combinations of protein, the coloring matter, &c.—enter the liver when it is in a state of action, and are there put in contact with the gall during its secretion, and with the substance of the liver itself, which is in a state of continual alteration, then the result will be, that this change of their component parts having taken place, the action will be transferred to the elements of the blood, and will maintain the secretion. If, on the other hand, the constituents of the blood are in a state of continual change, then the circle of action in which they are involved will extend to the mass of the liver; and so with every organ (§ 18).

"We have, however, no more knowledge of the manner in which this secretion originally commences—whether it proceeds from the blood or from the secreting organ, [!] or whether each of these contributes its part—than with the manner in which the first germ of the whole organ, the liver, is produced, or in which the germ of the animal is converted into an animal. But the continuance of the action—the duration of secretion—entirely corresponds with some other phenomena, which we may observe separately, and which therefore throw light upon these animal actions. This is the case especially with *fermentation*, from which Liebig has drawn many illustrations, for the purpose of clearly exhibiting his ideas; and with the same view we shall also avail ourselves of this process.

"Yeast changes sugar into carbonic acid and alcohol, and is at the same time changed itself. The latter change causes the former, and is only transferred to the sugar. If we substitute *blood for yeast*, and the *liver for sugar*, we may form an idea, more or less distinct, of the *secretion of the gall*. [!] The component parts of the blood are continually undergoing change. This constant change of the component parts in organic bodies is a chief cause of the continuation of their existence. The liver without intermission assumes new parts and loses others. This process we call nutrition. At the same time that the parts of the blood in the substance of the liver are thus undergoing change, chemical forces are excited; these forces are transferred to the elements of the blood, and so are enabled to produce from them the gall. This takes place the more easily, as the blood itself is also in a state of continual alteration, and thus readily yields to the impulse which, in some way or other, is communicated to it. As the impulse varies, so does the effect. Hence that great diversity in the secretion of very dissimilar substances, which are in a state of alteration, from the same fluid—that is, the blood, which is itself at the same time in a state of decomposition."—MÜLDER.

$350\frac{3}{4}$, *f*. In our next quotation we have an assumption founded on a begging of the very question at issue; that is to say, whether there be or not a radical difference in the original constitution of organic and inorganic nature. The author having assumed that there is no difference, proceeds, by the force of surmised analogies drawn from the probable constitution of inorganic matter, to repeat the assumption already stated that there are no other properties in living beings than such as exist in the elements of matter. Thus:

"The idea of *communication of forces* is unsound; it is only what is substantial that we can communicate. Forces may be *excited*, they cannot be *communicated*. Hence it results that every transformation in plants is effected by the molecular forces of carbon, hydrogen, oxygen, and nitrogen,—the elements of carbonic acid, water, and ammonia,—the forces being excited in these elements by the plants themselves." "Any one who imagines that there is any thing else in action than a molecular force, than a CHEMICAL FORCE, *sees more* than exists. The *forces excited in the elements* vary with the influence which certain agents—temperature, moisture, light, &c.—exert. By the aid of crucibles and retorts, therefore, compounds can be formed which differ from those produced by the organs of plants; while, from carbonic acid and water, plants can produce *cellulose* and oxygen, a result which CANNOT YET be imitated by art." "To express our idea in a

few words:—The elements of the organic kingdom, carbon, hydrogen, oxygen, and nitrogen, are susceptible of endless modifications. For that reason they can form, with minute changes, a great diversity of products (§ 41); and by the operation of the same *primary* forces, they stand toward each other *in entirely different relations from those assumed by all the other elements;* so that THEY CAN PRODUCE *a peculiar series of bodies, which are called organic substances*"!* "Organic substances, whether called germs or food, possess properties of a PECULIAR KIND, EXISTING IN THE FOUR ELEMENTS of which they are all constituted"!—MÜLDER..

350¾, *g*. The difficulty, therefore, with the chemists appears to lie in their habits of reasoning exclusively from what they observe of inorganic compounds and their elements, and an indisposition to admit that the Almighty superadded to organic beings a principle of life, while they allow the special creation of mind in animals. Nor does their philosophy permit them to imagine that the former may be as capable of governing all the processes of organic, as the latter is of animal life, and that the principle of life may be supposed, with as much reason as the principle of intelligence, to be imparted by the exact organization perpetuated from the Almighty Hand to new accessions to that organization; while the phenomena of life are far more multifarious and conclusive of the existence of a special principle than such as oblige the chemist to yield his assent to a mental principle distinct from the matter with which it is associated. Why, then, does not the chemist equally maintain the existence of mind, as of the properties of life, in the elements of matter, and that its development is alike owing to a difference of circumstances? Does he fear that this stretch of materialism, this act of philosophical consistency, or his neglect to abjure the obvious inference, may impair our confidence in the apparently though not really less objectionable scheme of reducing organic life to the virtual condition of the simple elements of matter, and thereby divest the Creator of His great Prerogative by attributing creative power to those elements (§ 14, *c*)?

350¾, *gg*. But, let us hear the chemist upon this interesting point. And Liebig, first; who, also, shall show that no injustice is done by the preceding remarks. Thus:

"The higher phenomena of mental existence cannot, in the present state of science, be referred to their *proximate, and still less to their ultimate* causes. We *only know* of them that they exist. We ascribe them to an *immaterial agency*, and that, in so far as its manifestations are connected with matter, an agency entirely distinct from the vital force, with which it has nothing in common."—LIEBIG'S *Animal Chemistry.*

"Physiology has sufficiently *decisive grounds* for the opinion that every thought, every sensation, is accompanied *by a change in the composition of the substance of the brain;* that every motion, every manifestation of force, IS THE RESULT *of a transformation* of the structure or of its substance."—LIEBIG'S *Animal Chemistry.*

And now the other able and distinguished chief:

* See my "*Notice of Reviews,*" ut cit, and my "*Examination of Reviews,*" p. 43, 44, in "Commentaries," vol. iii.

"I will not *venture* to raise the veil, by which the ACTION OF THE NERVES, or the HIGHER FUNCTIONS OF THE MIND, have hitherto been shrouded from observation. As man HAS an IMMATERIAL and immortal part, *which is identical with his real being*, and of which alone he will consist, when the material frame by which he is bound to the earth, shall be dissolved; and, as the inferior animals possess, in common with man, certain powers of perception, associated with certain appropriate organs, whose functions have no connection with consciousness; so do animals and plants perform in common a great many operations which are distinct from BOTH of those now mentioned, of which, at least, have their origin in DISTINCT CAUSES.

"It is only the LATTER CLASS of which I speak, and to which I apply the general term of *organic life*. To that subject I shall restrict my remarks."—MÜLDER, *ut cit.*

Now, I say, 1st. Why not "raise the veil from the *action of the nerves*" in a professed work on physiology, and a work, too, which would revolutionize the science? Have you no phenomena to guide you in "raising the veil?" Do you fear their contact with the phenomena of the laboratory? Is it right to make this declaration, and then to refer a vast series of phenomena exclusively to "organic life," which could have had no existence without the "action of the nerves" (see § 350, no. 18½)? I deny, too, 2d, that "the higher functions of the mind have hitherto been shrouded from observation;" and I am supported by all who truly believe in the independent existence of mind, in the affirmation that its "functions" are characterized by an infinitely greater variety of unique phenomena than are the processes of inorganic nature. There is no "veil to be raised" in this or the other case. It is, indeed, by the recognition of these phenomena that our author feels obliged to admit the existence of "an immaterial part," however inconsistent the simultaneous declaration that "the functions of the mind have hitherto been shrouded from observation." And, I am alike sustained, also, and by every dictate of philosophy, in the conclusion that, if the phenomena of mind are decisive of the existence of "an immaterial part," so are the far more varied, and numerous, and equally unique phenomena of organic processes, conclusive of the existence of some not less peculiar force, power, or "immaterial" or *material* "part," upon which they depend. In any event, however, the physiologist has a right to insist that the chemist shall not reject all considerations relative to the "*action of the nerves*," when he invades organic nature with retorts, crucibles, acids, &c.

"Analogy is," undoubtedly, as Bacon says, "the basis of all the sciences." Nature, throughout, is bound together by analogies. The principle reaches from the Creator to the mind of man, to his "immaterial and immortal part." And so it does from the force and the properties of life to those of dead matter. Here is the delusion of the chemist. But, there is even a wider difference between the *formative principle of life* and *destructive chemical affinity*, than there is between the Creative Spirit of God and the created, dependent spirit of man.

350¾, *h*. The grand characteristic of organic life is *the principle of life*, capable of imparting that principle to matter which is destitute of it, and which it retains only while in its proper connection with the being by which it was so endowed. The doctrine which refers the

properties of life to the elements of matter is *atheistical* in its application (§ 14 *c*, 74, 175); and the recognition, simultaneously, of a "Creative Power," is but another *conventional* word for *nature*, or designed to protect the doctrine against the fatal imputation of irreligion (§ 64, *h*). That imputation, however, is indelibly stamped by nature herself. The mode of defense is well shown in the late highly lauded and popular work on the "VESTIGES OF THE NATURAL HISTORY OF CREATION," in which the author considers La Place's infidelity as to the *modus operandi* of matter in forming the Universe, and the doctrine of spontaneous generation in its most ample extent. The author's defense of Mr. Crosse's creation of animals out of silex is a good example of the specious reasoning by which so many are cheated into projects which contemplate the worst results to philosophy and religion.* Thus:

350¾, *i.* "The supposition of impiety arises from an entire misconception of what is implied by an aboriginal creation of insects. The experimentalist could never be considered as the author of the existence of these creatures except by the most unreasoning ignorance. The utmost that can be claimed for, or imputed to him, is, that he arranged the natural conditions under which the true creative energy, that of the Divine Author of all things, was pleased to work in this instance. On the hypothesis here brought forward, the ACARUS CROSSII [!] was a type of being ordained from the beginning, and destined to be realized under certain physical conditions. When a HUMAN HAND brought these conditions into the proper arrangement, it did an act akin to hundreds of familiar ones which we execute every day, and which are followed by natural results, but it did NOTHING MORE." The defense of La Place's system proceeds upon the same specious assumption.

Now the foregoing doctrine transcends not only the usual geological hypothesis of a successive creation of animals, but that, also, of spontaneous generation; both of which are, of course, anti-Mosaic, and regardless of the established order of creation (§ 303 *a*, 303¼). But here we have an exemplification of a strictly atheistical expedient, in the attempt to assign the existence even of organic beings to the merest chance, under the pretext of ascribing to that chance the intrinsic attributes of a Creative Power, and the imposing title of "the Divine Author of all things"! It is the same with each and all who allow a God, a Creator, &c., yet reject entirely His Revelation as to creation, supported as it is by the most consummate and endless systems of Design. It is the old expedient of the wolf in the disguise of the sheep (§ 14 *c*, 64 *h*, 74, 733 *d*).

350¾, *k.* Nevertheless, the foregoing work is powerfully sustained by able articles in the BRITISH AND FOREIGN MEDICAL REVIEW for January, 1845, consisting of twenty-six pages of eulogistic remarks; and in the MEDICO-CHIRURGICAL REVIEW for the same month, of ten pages not less congratulatory. The work was published late in 1844, and, although not at all relevant to medicine, it was taken up with avidity by the two leading medical journals of Europe, and an effort

* See *Medical and Physiological Commentaries*, vol. i., p. 707; vol. ii., p. 96. In vol. i., *Grass* is a typographical error for *Crosse*. It is also possible that the "created animals," instead of being "crystalized spiculæ," were real animals evolved by the action of galvanism from ova contained in the water (see § 74, 188½ *d*).

made to prepossess the medical profession before the work itself should fall under their observation; observing in this respect the system which was almost universally pursued by the periodical press even in anticipation of Liebig's work on *Animal Chemistry.*

In my Essay on *Spontaneous Generation*, embraced in the *Medical and Physiological Commentaries,* I have had occasion to refer to the charge of infidelity which is often laid against the Medical Profession. I have there, too, defended that Profession against so great an injustice, and have held responsible the proper Sources that have given rise to this imputation. I have also shown that that imputation is greatly due to the cultivation of the chemical and physical hypotheses of life, to which the foregoing Reviews have been laboriously devoted. In conclusion of the whole matter I have said that,

"The steps are gradual from the incipient errors in natural philosophy to a disbelief in the Mosaic Record of Creation. When we have ultimately reached the brink of the precipice, there is but one dreadful plunge, and we are then in the vortex of atheism. We may begin, as I have said, by a simple denial of the living powers of organized beings, when it will become, at last, an easy argument upon this, and analogous premises, that the Almighty had but very little, if any agency, in the most sublime part of existences."

"Let *philosophy* interrogate nature to its fullest satiety, under the direction of its Heaven-born principles; but let it be consistent, and maintain its dignity. And should it sometimes, as it must in its wide range of nature, come in contact with miracle, that is its limit, contented that it begins at the confines of Creation; yet still may it stretch into the regions of Eternity, past and to come; but now it is employed in its nobler work of sacrificing its relations to second causes, and in establishing relations with the FIRST CAUSE OF ALL." —*Medical and Physiological Commentaries*, vol. ii., p. 140.

350¾, *kk.* It is now my purpose to quote the foregoing Reviews in connection with the "Vestiges of Creation," partly for the object just assigned, and in part to supply other examples in justification of what I have said in behalf of the Profession, and of the tendency of the chemical and physical hypotheses of life and disease to lay the foundation of a grosser materialism, and of infidelity in Religion (§ 175). It seems peculiarly appropriate that Reviewers, who wield an extensive and powerful sway, and whose occupation it is to defame whatever molests that dominion, should be used for the contemplated purpose, and this, more especially, as both Reviewers offer defiance to the "Saints," and the "timid religionists." The Reviews are conducted with great diligence and research. Their influence is coextensive with medicine. That influence must be sapped by a display of its tendencies. There can be no difficulty with a defense of the right. The inculpated are able, their means ample, their coadjutors numerous and powerful, the public generous, and, as I said on a like occasion in the *Commentaries*, "I am single-handed, and have nothing but facts for my weapons" (vol. i., p. 391).

Infidelity is certainly a term which should be well sustained in its application; better, at least, than when applied to myself by the first of the following journals (see *Examination of Reviews,* p. 84–88). As it respects the Reviewers, the imputation appears to be invited and expected, as an obvious consequence of the doctrines advanced;

and, although I do not belong to the denomination of "Saints," or of the "timid religionists," it is not less my duty as a man, and as an expounder of the Institutes of Nature, to bring those institutions to operate upon infidelity. There can be no place more appropriate for looking "through Nature up to Nature's God," than in the general survey of organic beings. If ordained in their organization and their laws by a higher Power, that organization and those laws may well be urged in proof of their Origin. Then, too, shall the minister of health realize the importance of the Institutes of Medicine, and the spirit of the Hippocratic maxim, that "a philosophical physician is like a god."

I shall quote a passage of general import from each of the foregoing Reviewers, that no doubt may linger upon the mind of any reader as to the justice of the criticism which I have now exercised in behalf of religion, of morality, of the dignity of medicine. The *emphasis* is mine.

And first the elder brother; beginning thus:

"This is a remarkable volume, small in compass, but embracing a wide range of inquiry from worlds beyond the visible starry firmament, to the minutest structures of man and animals. No name is prefixed,—perhaps in order to avoid the snarls of the narrow-minded and bigoted SAINTS of the present day," &c.

The middle thus:

"For how many millions and millions of years this production and reproductions of animals went on before man made his appearance on the scene, no human being will ever know. [!] In all probability, countless ages must have elapsed, before this master-piece of creation appeared. Our author's speculations on the *how*, the *why*, the *when*, and the *wherefore* this great event occurred, will not give satisfaction to the *present* RACE of mankind. [!] His hypothesis is three or four centuries in advance of the TIMES, and will be stigmatized by the modern SAINTS as downright atheism," &c.

And the end, thus:

"We have dedicated a space to this remarkable work that may induce many of our readers to peruse the original. The author is decidedly a man of great information and reflection. He will have a host of SAINTS in array against him, and many will join in the cry, *from hypocrisy and self-interest*. As we said before, his doctrines have come out a century before their time."—MEDICO-CHIRURGICAL REVIEW, p. 147, 153, 157. *London*, Jan., 1845.

Next, Dr. FORBES, in the *British and Foreign Medical Review*.

"This is a *very beautiful* and a *very interesting* book. Its theme is one of the grandest that can occupy human thought,—no less than the CREATION OF THE UNIVERSE." "We are also influenced by the abstract desire to place before our readers matter for their contemplation, which cannot fail at once to *elevate*, to *gratify*, and to *enrich* the mind. It has always been one of the boasts of our noble profession that it touches and blends with every science; and we should be sorry that our humble efforts should at any time be wanting to stimulate its professors to exertions that might still justify the boast"!

Of La Place's nebular hypothesis, he says:

"So far from admitting the atheistical tendency which TIMID RELIGIONISTS have attributed to the nebular hypothesis, *we consider it the grandest contribution which Science has yet made to Religion*," &c.

The reader, therefore, will have no difficulty in understanding the "conventional" nature of certain phrases in the following remarks by Dr. Forbes. (See *h*.)

"That the Creator formed man out of the dust of the earth, we have *scriptural* authority for believing, and we must confess *our own predilection* for the idea, [!] that, at a period however remotely antecedent, the *Creator* endowed certain forms of inorganic matter with the PROPERTIES REQUISITE TO ENABLE THEM TO COMBINE, AT THE FITTING SEASON, INTO THE HUMAN ORGANISM, [!!] over that which would lead us to regard the great-grand-father of our common progenitor as a chimpanzee or an orang-outang."—BRITISH AND FOREIGN MEDICAL REVIEW, p. 155, 158, 180. *London*, January, 1846. (See *l*.)

The author of the *Vestiges of the Natural History of Creation* is thus quoted by Dr. Forbes:

"We have seen powerful evidence that the construction of this globe and its associates, and, inferentially, that of all the other globes of space, was the result, not of any immediate or personal exertion of the Deity, but of NATURAL LAWS which are expressions of His will. What is to hinder our supposing that the ORGANIC CREATION is also a result of NATURAL LAWS which are, in like manner, an expression of His will?"—NATURAL HISTORY OF CREATION.

Upon the foregoing extract, which is a part of a more extended one of the same nature, Dr. Forbes remarks, that,

"The COMPLETE ACCORDANCE OF THESE VIEWS with those some time ago PROPOUNDED BY OURSELVES (vol. v., p. 342), must be evident, we think, to our readers. To the objection which some TIMID RELIGIONISTS may urge against them, that they are inconsistent with the Mosaic record, we simply reply with our author, that we do not think it right to ADDUCE THAT RECORD either IN SUPPORT OF, or in objection to, *any scientific hypothesis*, based upon the phenomena of nature," &c.! —BRITISH AND FOREIGN MEDICAL REVIEW, p. 167.

Dr. FORBES assumes, of course, that all the misapprehensions and perversions of "the phenomena of nature" are paramount to any thing declared in the Mosaic Record (§ $5\frac{1}{4}$, 74, 733 *d*).

The most superficial reader cannot fail of discerning in the foregoing principles, as in many other analogous instances, the motives which have induced those foremost medical Reviews to lend their powerful aid in propagating the materialism of Carpenter, the absurdities of Liebig, the humoralism of Andral, and the putrid anatomy of Louis, and of their respective schools; and why, on the other hand, they have been equally regardless of truth in their vocation as critics on the labors, the researches, and the statements of others.

$350\frac{3}{4}$, *l*. I have already shown in this and other works how convenient a matter it is for "the properties of life in the elements of matter" to bring these elements into an organic state. And since I am now on the subject of the first and greatest step in the process of *vivification*, it may be useful, as it is appropriate, to show how the advocates of "the properties of life in the elements of matter," and the propagators of spontaneous generation, and eminent geologists who promulgate a successive creation of animals according to their scale in organic nature and in conformity with the development of new physical agencies, ay, and certain eminent vitalists whose otherwise sound philosophy should have enlightened them as to the Great First

Cause—in view of all these things, I say, it may be conducive to sound physiology to show how the foregoing schemers of "creation" arrive, in part, at least, at the conversion of organic matter into the complex fabric, after that matter shall have been duly compounded by "the properties of life which reside in the elements." For this purpose I will take the statement of the distinguished vitalist Tiedemann. Thus,

"The most probable hypothesis is, that the *substance* of organic bodies existed primitively in water, as matter of a particular kind, and that it was *there endowed with the plastic* faculty; that is to say, with the power of acquiring, by degrees, different simple forms of living bodies, with the concurrence of the general influences of light, heat, and perhaps also of electricity, &c., and of then passing from the simple forms to other more complicated; varying in proportion to the modification occurring in the external influences, until the point when each species acquired duration by the production and manifestation of activity of the genital organs"!—TIEDEMANN'S *Physiology of Man.*

That is the doctrine, candidly avowed by those to whom genius and the conviction of a right discernment of the ways of nature impart a fearless independence, however it may be disguised by others under the "conventional term" of *creation.* But, Tiedemann is a philosophical vitalist, and did not confound the principle of life with the forces of inorganic matter, nor, like Carpenter, Fletcher, Prichard, Roberton, Forbes, &c., place the properties of that principle in the elements of matter. He started with matter in more or less of an organic state, and leaves it problematical how its elements became united into that peculiar vital compound. He did not even imply that the elements being so endowed could organize themselves, for he adds to the foregoing statement, that,

"Although we cannot here answer the question, *whence* came the water and the *organic* matter which it contained, yet this hypothesis is the one which accords best with *the facts with which geology has lately been enriched.*" And again, "If it be asked, *whence organic matters proceed, how* they are produced, together with *the power of formation inherent in them*, we are necessitated candidly to confess our ignorance on the subject, inasmuch as the *first origin* of organic matters and living bodies is altogether beyond the *range of experiment.*"—TIEDEMANN'S *Physiology of Man*, p. 14, 193.

It will be thus seen that even Tiedemann's doctrine enjoys "a loophole" which cannot be allowed to those who place "the properties of life in the elements of matter," or who endeavor, or propose, to create organic compounds in the laboratory of the chemist; since, in respect to the latter, were the production of *organic compounds* within "the range of experiment," the accidental nature of the origin of such compounds, and, therefore, the incipient being of man, would be established by the laboratory. And now I ask, does not the organic chemist attempt or profess to create organic compounds? So says Liebig, § 350, no. 39, and so say most other distinguished chemists. Liebig and his disciples create the *compounds;* Crosse and his followers create the *animal.* Others do but make the *attempt;* and this is a very numerous class who thus enter into competition with the ORIGINAL AUTHOR of organic compounds. What, therefore, is the difference in principle between him who pretends to have succeeded

in this work of creation, and the other who has attempted the work, but without success?

From the physiologist who advocates the existence of "the properties of life in the elements of matter," we hear that,

"There is no reasonable ground for doubt that if the elements could be brought together in their requisite states and properties *by the hand of man*, the result (artificial organic compound) would be *the same* as the *natural* compound." Again, "that the *germs* (of parasitic plants and animals in the interior of others) have been conveyed *from without* into the situations where they are developed, must be held as a *very forced supposition*"!—CARPENTER'S *Principles of General and Comparative Physiology*, p. 146, 395; *also, this work*, § 14 *c*, 175 *c*, *d*, 189 *b*.

350¾, *m*. Mülder has the manliness to carry out the obvious tendency of his doctrines, which may be expressed in a brief quotation. Thus,

"Upon the principles which have been stated, no room is left for the dispute as to *equivocal generation* and *epigenesis*." Nevertheless, it is allowed by Mülder that cellular structure "cannot *yet* be imitated by art." But, waving this conceded difficulty, if the physiological arguments which I have advanced in section 14 *c*, as to a real Creator, can be invalidated, I shall concede that a ground has been obtained for the doctrine of spontaneous generation.

350¾, *n*. As I shall soon dismiss this author, it may be useful, in consideration of his exalted worth as a chemist, and his authority among physiologists, to show that even one who endeavors to hold a consistent philosophy on the subject of chemical physiology, yet sees in organic beings so much to contradict his chemical doctrines, that he evinces the usual inconsistency of those who have endeavored to confound the science of life with that of chemistry (§ 4½, *d*). For this purpose I shall select two passages only, and place them in parallel columns, after the manner adopted in relation to Liebig in section 350. I shall elect, also, for the *negative* side, a passage which will show, what cannot be too often repeated, that the chemists are absolutely regardless of their own fundamental doctrine, of "ascending from phenomena to their causes," by rejecting all the unique phenomena of life as indicative of any peculiar force or laws. The *affirmative* side, however, is all that the vitalist denies (§ 189).

Denial of the Vital Principle and Vital Properties.

"Wherever forces are found in organic nature, there are substances which are all supplied with molecular CHEMICAL FORCES. Even those singular structures, the nerves, consist of the same elements as the ordinary substances of the organic kingdom. It is thus undeniable, that the MOLECULAR FORCES act a chief part in the organism, so far as a change of substances takes place therein;

Recognition of the Vital Principle and Vital Properties.

"The question is, whether, during decomposition, the ORGANIC FORCES grow weaker of themselves, permitting the elements to obey their *primary tendency*,—or whether causes must exist by which these ORGANIC FORCES are made weaker? Neither is improbable. Every thing which ceases to be subject to the VITAL PRINCIPLE, becomes incapable of being stimulated by the VITAL

and that NO GENERAL, NO VITAL FORCE, should be assumed as the source of those molecular forces. Such a vital force is irreconcilable with the true principles of science, which require that nothing should be *assumed* as existing, but that every thing should be *sought for* in nature; which teach us to ascend only from an unprejudiced consideration of the phenomena to their causes, and to assign those causes only as we deduce them from the observed phenomena."—MULDER'S *Chemistry of Vegetable and Animal Physiology*, p. 68. 1845.

FORCES;—it is placed in other circumstances; and as the PRODUCTS OF THE VITAL FUNCTIONS ARE DIFFERENT FROM THE PRODUCTS OF INORGANIC NATURE, in consequence of the very difference of the circumstances in which the elements are placed, so the products of substances, deprived of VITAL INFLUENCE, must also GREATLY VARY with circumstances. Hence it may happen, that THE FORCES present in organic substances, when deprived of the VITAL INFLUENCE, may DISAPPEAR of themselves. The impression they had at first received is changed, modified, OBLITERATED, and therefore the effects can no longer be the same. A substance persists in the state into which it was *first put*, according to the law of INERTIA; but the maxim, *sublata causa tollitur effectus*, is of EQUAL VALUE."—MÜLDER'S *Chemistry of Vegetable and Animal Physiology*, p. 54 (§ 59).

I shall conclude with an extract from Mülder, in which it will be seen that he has adopted the method set forth by myself in my *Essay on the Philosophy of Vitality*" (1842), of investigating the subject in the development of the germ. It may be useful to place in contrast the purely chemical and the purely vital interpretations of that development (§ 65). I may also premise that it should be observed that the chemist keeps out of view all the remarkable circumstances attending the development of the egg which I have set forth as irreconcilable with chemical phenomena, and limits himself to statements founded on a supposed analogy with the simple results of chemical affinity as observed in inorganic nature. Thus:

"If we review the phenomena of life, caused by change of materials, we must go back to the original formation of organs—to the growth of an individual from a germ." After illustrating the develment of the germ by "an example from the inorganic kingdom" (the formation of prisms from a solution of the sulphate of soda!), this distinguished chemist proceeds to say, that

"Undoubtedly the differences which exist between the particles of the same organic substances are not chemical, in the ordinary gross signification, but are of the nature of those which are connected with polymorphism. The chemist gives us but a rude result—the composition in a hundred parts, frequently not affording us any insight into either the real characters of substances, or into their real differences. Whenever such dissimilar particles come together, a compound must be produced, possessing peculiar forces, which, though dependent upon

the molecular forces of the elements, are yet not determined by these alone. The new arrangement causes a modification of those primary forces. Whenever it takes place, they appear modified, and therefore indicate their presence by producing new effects. In sulphate of soda, the whole collected forces of its constituent molecules—those of sulphur, sodium, and oxygen—are still existent; and upon these alone depend its qualities, composition, and crystaline form. Sulphate of soda cannot possess other qualities—cannot become other in property—than what results from its elements, and exclusively originates in these.

"Thus, then, we suppose that the molecules of the substances in the embryo are arranged, in the first place, simply, and afterward more complexly. Not a trace of any organ is as yet perceptible, however; nor of any force, therefore, by which these organs will be governed. By the new arrangement of the particles, the molecular forces are modified anew, and this process is continuous. Although the primary forces, once united with the materials, remain the source of every action, of every manifestation of phenomena, of every chemical and organic, that is, physical, combination; they must, nevertheless, produce different effects, as the combinations become more complex. Each existing particle is the germ of a subsequent one, which is more complex; and, while the temperature necessary for hatching keeps the primary forces always excited, there is originated in the new arrangement of the particles, and also in the forces proceeding from the groups recently formed, a modification of these primary forces, which is constantly on the increase.

"The whole material of the embryo in the egg is gradually brought in this manner within the circle of action. Then the circle is still more extended, and in its action are comprehended the elements of the yolk, and also of the albumen. These are erroneously called the food of the newly-formed chicken, or its rudiments. In these elements there are forces also conjoined with the materials—chemical forces, analogous to those which exist in the embryo, and contributing to the production of the whole. These forces differ from those found in the embryo, not in nature, but only in direction, or in the mode of manifestation."—MÜLDER, *ut cit*, p. 71–73.

351. Having in the preceding sections, as well as at other times, summoned, in behalf of truth, and of the noblest institutions of nature, an adverse party, and having shown, not only by the nature of the pursuits which engage the whole practical attention of the leaders of that party, but by an open cross-examination of the acknowledged chiefs, that the entire field of physiology and medicine remains, as ever, in sole possession of those who are employed in its cultivation, and that, by no possible accident, fraud, or conspiracy, can it be transformed or transferred into the laboratory of the chemist, I shall proceed to a more critical examination of the philosophy of digestion, both in its vital, and its supposed chemical attributes.

352. All other processes of living beings, whether animal or vegetable, and especially the whole work of assimilation after the entrance of the food within the lacteals, being exclusively vital, it follows, as a great analogy of nature, that the first step in the process of assimilation is equally due to vital influences (§ 323–326).

353. Since every species of animal possesses some peculiarity of

organization, not only of the alimentary canal, but of the liver, salivary glands, pancreas, teeth, jaw, skeleton, muscles, and also of instinct, corresponding with a certain modification of the vital endowments of the gastric juice in each species of animal, which shall be exactly, and forever, and undeviatingly suited to the digestion of those kinds of food which were ordained by the Creator for the sustenance of each when He thus wonderfully instituted this almost endless system of exact Designs; each individual part having its specific final cause, each final cause modified in every species and with corresponding peculiarities of organization, and all concurring to one great final cause of subserving those exigencies of life which are fulfilled by the gastric juice, and whose modifications in different species of animals harmonize with the special attributes of all the concurring causes, and so suited by Infinite Wisdom to the nature of the food of every animal, that its *incipient* change shall be one of assimilation to the nature of the being, yet nearly coincident in all animals from the general coincidence in all organic compounds; I say, in all this labyrinth of Designs, so exactly modified in every species, yet correspondent in all, and each and all, in their individuality, their variety, their modifications, and their unity of purpose, having a specific reference to the alimentary material of each species of animal, we see in perpetual progress what is equivalent to a never-ending voice from Heaven, proclaiming that the organic stomach has no parallel in its capabilities and results in the inorganic world, or in the laboratory of the chemist. But this is not all; nor will I fail to convert the stupendous whole, as I advance with the details of assimilation, to the fundamental philosophy of organic life.

354. The constituent elements of the food having been subjected to special transformations, and imbued with the first gradations of life, by the vital action of the salivary and gastric juice, and perhaps, also, by contact with the stomach, is thus converted, in all animals, into apparently one and the same homogeneous product. It is then submitted to the farther organizing effects of the bile and pancreatic juice, passed through the wonderfully vivifying lacteals, carried forward and subjected to the whole animating influence of the pulmonary system, perfected in its exalted endowments by the whole labyrinth of the circulatory organs, and, lastly, though not least, the various compounds are determined, each and all, from *that one* homogeneous fluid, and in one everlastingly exact manner, and according to the nature of each part, by other complex living systems, and thus perpetuated forever in all their exact varieties,—but *how*, no imagination can form the most remote conception, but through the instrumentality of those specific properties of life which were the only power concerned from the beginning to the ending of the astonishing series of unvarying changes (§ 42); and, however it be that each ultimate product is destined for the immediate uses of the individual, it is undeniable that *the great final cause of every step in the assimilating process, till it results in the formation of blood, is the reproduction of gastric juice* for the maintenance of an unceasing supply to the exigencies of organic life, and the perpetuation of the species (§ 41, 323–326).

355. The gastric juice being designed to prepare the material for the formation of blood, has its powers so constituted as to be merely an agent. The blood, being the *pabulum vitæ* fully prepared for the

regeneration of the gastric juice, as well as of other organic compounds (§ 354), is mostly a substance acted upon by the living solids, or by the fluid ovum, just as the food had been by the gastric juice, while it serves, also, as a stimulus to the vascular parts, and is highly endowed with the properties of life to facilitate its conversion into living solids or fluids, and to make its presence in the blood-vessels compatible with their life.

356, *a*. And thus pursuing, and while describing, the various details of assimilation, attention is unavoidably arrested by the magnificence of its unique philosophy, and by the ultimate aim of every detail, of all the immense variety (§ 353–355), even excretion itself (§ 412, &c.), at the production of gastric juice! And as we penetrate the more latent, but yet more impressive physiological laws to which that juice is obedient, we rise in admiration of the preliminary means of their fulfillment; and now again addressing myself to the chemist, I ask him as a philosopher, as one who would protect the consistency of his own science, what can be more emphatically significant of the abstraction of digestion from chemical agencies, than the fact that the nervous power so modifies the vital constitution of the gastric juice that it fails of its usual function when a division is made of the pneumogastric nerve? Imagination can surmise no connection between the nervous power and the processes of chemistry. And yet do the writings of Liebig, and of other organic chemists, abound with assumptions that the supposed affinities of chemistry, as operative in animals, are subject to the nervous power! though it is conceded that the nearly coincident processes and results in plants sustain no such nervous influences (§ 500, *n*). "*The animal organism*," says Liebig, truly, "*is a higher kind of vegetable*." To suppose that such powers operate in harmony together, and that the mind or its passions are capable of influencing, extensively, the operation of chemical forces, in constantly modifying the various secreted products, both as to quality and quantity, is a positive violation of the most obvious and universal rules in natural philosophy (§ 500, *n*).

356, *b*. It is evident that a great difficulty exists with many, who admit a principle of life in relation to the solids, in imagining a fluid to be equally endowed, and alike capable through that principle of acting upon organic matter. But we must take the facts as we find them, nor allow inorganic nature the slightest interference. If analogies must be had, let us seek them in the organic being, and we shall be certain of success. In the instance before us, we have the admitted vitality of the blood; but, unlike the gastric juice, it produces no changes in matter. We have, however, the fluid ovum, "*whose vital properties*," in the language of Dr. Carpenter, "*confer upon it the means of itself assimilating, and thereby organizing and endowing with vitality the materials supplied by the inorganic world*" (§ 64, *g*). Here, then, the analogy is remarkably forcible, and the more so, as the fact is conceded by the strictly chemical school of digestion. So, of the semen, in another aspect of the active condition of the principle of life in an organic fluid; this substance, through that principle, being capable of modifying the organic constitution of the ovum in such wise, that the offspring shall inherit the intellectual, vital, and physical peculiarities of the male parent, with six fingers instead of five (§ 72, 73).

357. One of the most important arguments in favor of vital diges-

tion consists in the remarkable *endowments* of the stomach, as manifested by its vital signs, and by the sympathies which prevail between this organ and all other parts. The final cause of this peculiar constitution of the stomach, this lavish supply of the properties of life, this subservience of other organs to its dominion, must be sought in its adaptation to the generation of a fluid that may bestow the first and most difficult act of vitalization upon dead matter (§ 356, *a*). There would also have been something harsh and abrupt in nature, to have admitted into the recesses of her living organization mere dead matter. It is opposed to all analogy, and is, therefore, opposed to all reason. But, that a fluid should perform this astonishing office, this first and great step in the ascending series, it must possess in a high degree the principle of life. Mysterious as it may be represented, we must all of us come at last to the admission of the existence of a vital principle; yet far less mysterious, and far less difficult of comprehension than the human soul. It is fair, then, to conclude that an organ destined for such a high function should possess that principle, in common with all other parts, as the means on which its function depends; and the best evidences in favor of this analogical inference are to be seen in its diversified manifestations of life.

358. We have seen, also, that it is conceded by philosophers who defend, *in extenso*, the chemical hypothesis of life, that there may be *something* appertaining to the stomach totally distinct from the chemical powers, and which is capable of imbuing the chyme with *vitality* and an *organic* condition; and it is, therefore, quite a philosophical conclusion, that this *vital something* has an important agency in preparing the material for the admitted exercise upon it of the vivifying or organizing power. Nor can there be any valid objection to the supposition that this vitalizing power, which so far transcends the chemical forces in the organizing effect it is allowed to exert, may be fully adequate to any transmutations the food may undergo; and this inference is the more corroborated by the consideration that matter already in an organic state must be better fitted for the process of vivification, than it can possibly be after its elements are broken up and recombined by forces with which those of life are in absolute opposition. Besides, the vitality of the gastric juice, or the vital influence of the stomach itself, being fully admitted, and even capable of organizing the food anew, this, in itself, should protect the alimentary matter against any chemical agencies which have been supposed to operate. That this counteracting power, indeed, prevails to the full extent which I have alleged, appears to be rendered certain by the ordinary absence of any of those chemical changes which take place where numerous substances are mixed together out of the stomach—substances which often possess strong chemical affinities for each other, and whose operation within the stomach would be promoted by its high temperature. On the contrary, whatever the variety, it is uniformly resolved into one and the same homogeneous substance, utterly unlike the results of chemical reactions of one kind of food upon other kinds; and what is also as conclusive as it is astonishing, the chyle is apparently the same substance in all animals. Chemistry must here be consistent with itself, and not renounce, for the sake of hypothesis, those precise laws by which, in its legitimate pursuit, it lays open, with astonishing exactness, what had appeared the arcana

of nature. Here, too, upon the chemico-physiological hypothesis, is presented an instance in which it is necessarily assumed that the properties of life and the forces of chemistry act together in concert in converting dead into living matter—one destroying, and at the same moment the other vitalizing! while the assumption is contradicted by all that is known of the relation of these forces to each other (§ 338).

Nor may we lose sight of the demand of philosophy not to multiply causes, where one is perfectly adequate; and especially where it is admitted that all the others are of themselves wholly inadequate.

359. The last remark may be also equally applied to a common assumption which is set forth in the following apparently plausible manner: "The vitalists," says one of their opponents, "are loath to admit the operation of chemical agents at all, and would seem to consider it derogatory to suppose that any changes, save the subtle ones effected by the powers of life, are worked upon the aliment." "The *vital principle*," he says, "whatever it may be, incessantly makes use of chemical and mechanical agents for its purposes; and it is no more degrading to it to employ an acid liquid, and a triturating process, in order to digest the aliment, than it was to have recourse to bony levers, cartilaginous pulleys, and tendonous ropes."

Here, in the first place, will be observed an entire begging of the question as to digestion by an acid, since that has never been shown, and is the main point at issue. It is a perfectly unfounded and extorted inference from the factitious analogy supposed to be seen in the admitted mechanical movement of the food in the stomach, bony levers, cartilaginous pulleys, &c. But the pretended analogy, I say, is utterly inapplicable, were it admissible to reason from better premises of this nature to the existence of important facts which have no other foundation. The bony levers, muscles, tendons, heart, and large blood-vessels, are mere instruments acted upon by the vital principle, and have no part in the vital results, except as they are the passive instruments of the properties of life. The same distinction exists between the process of digestion, and the mechanical movement of the food in the stomach, or the "trituration" of the food, as it is erroneously called by the writer just quoted; since food is not triturated by the stomach excepting where that organ is designed to supply the place of teeth. There exists, I say, a total want of analogy between that mechanical movement of the food, and the assumed action of an acid; since, in the latter case, a radical change is supposed to be wrought in the alimentary mass, while no such change is wrought by the mere movement, or even by the trituration or grinding of food in the stomach. The contractions of the stomach, which are purely of a vital nature, facilitate the process of digestion; but they do no more than to expose the food freely to the action of the gastric juice, by which, alone, the conversion into chyme is performed. The contractions, or "trituration," are exactly on a par, as auxiliaries to digestion, with the teeth, or with the knife, which divide the food. The *acid* alone applies to the supposed chemical process of chymification. This is the only agent, involving the only force distinct from the vital principle that is supposed to operate, and to take part with the properties of life in the functions which belong to these properties. Nor is this all. Those chemical forces, or an equivalent agent, are sup-

posed to appertain to the gastric juice (a product of the most highly-endowed organ in the animal system); and through that product, and by that product, to operate independently of the vital properties, or, under their control. But, here it may be again affirmed that throughout nature there is not an analogical fact to warrant the conclusion; and with equal truth it may be said that there is nothing to aid our conception of the *co-operation* of the chemical and vital forces, while all that is known of their relations to each other proclaims their absolute independence.

360. But, again, it is the admitted final cause of the gastric juice to bestow life upon dead matter, while it is incontrovertible that inorganic matter is insusceptible of any such influence from gastric action. Every fact proclaims that nature has provided the *vegetable kingdom* for the purpose, especially, of determining organic combinations out of inorganic substances for the sustenance of animal life. In the language of Liebig, "The first substance capable of affording nutriment to animals is the LAST product of the CREATIVE ENERGY"—ay, "the CREATIVE ENERGY," he says, "of vegetables."—(*Animal Chemistry.*) It is manifest, therefore, that it would be an absurdity on the part of nature to have ordained that chemical agencies should operate even at the very threshold of life, at the very fountain for which she had provided elaborate means to subvert the combinations of chemistry, and to bring them into those entirely new arrangements that approximate the changes they are destined to undergo in the animal stomach. And far less probable is it, that this fundamental principle should be lost as we ascend from vegetable to animal organization; since every chemical result within the stomach would tend to reduce the aliment to the state of that inorganic matter whose complete reduction into organic compounds was effected by the vegetable kingdom for the uses of the animal. Such chemical results, therefore, would counteract the great final cause of nature, in either organic kingdom; and, in the animal, would render the means of sustenance more and more indigestible, and progressively liable to the condition of inorganic matter (§ 338). This is fully allowed by the chief of the school of pure chemistry, as shown in the foregoing parallel quotations. Take another summary statement, than which nothing can be more contradictory of the chemical rationale. "While no part of an organized being," says Liebig, "can serve as food to vegetables, until, by the process of putrefaction and decay, it has assumed the form of inorganic matter, *the animal organism requires*, for its support and development, *highly-organized atoms. The food of all animals, in all circumstances*, consists of parts of organisms."—(*Animal Chemistry.*) The chemical philosophy of digestion becomes, also, most obviously unfounded when it is considered that nutriment of an animal nature requires but little more than the solvent process, and the bestowment of vital properties; while, in accordance with the chemical hypotheses, animal compounds must be, more than vegetable, subject to disorganizing agencies, and thus more completely removed from their original and near approximation to the compounds of the living animal (§ 301, 303 *a*, 338).

361. But again I say, if the vital principle be "capable of making use of chemical agents," no reason can be assigned why it may not be equal to the whole work of digestion, and of every other process

of living beings. The *simple* construction may be comprehended, while the other is utterly unintelligible. The former alone is agreeable to the rules of philosophy, and abolishes the inextricable confusion which attends the chemical hypothesis. What, indeed, can be meant, by the vital properties making use of chemical forces? Can there be a more glaring absurdity? more absolute nonsense? How are those chemical forces brought into use, how held in subjection, how forever maintained in one exact operation in each particular organic process, of which there are multitudes, distinct from each other, going on in the same individual? How do they elaborate from one common, homogeneous fluid, either the blood, or the sap, all the various, unique, unchanging, secreted products of the whole organic being? Products, forever the same in every part, yet differing from each other according to the nature of the part? Did you ever hear or dream of any thing analogous to this in that inorganic world where chemistry holds its empire? When do those chemical forces begin to operate, in the living body, what part do they perform, and what is the allotment of the properties of life? Is there any *known* concert of action between the two species of forces? On the contrary, is it not every where demonstrated that the properties of life are in direct opposition to the forces of chemistry?

Whatever be the construction, by uniting the two forces (as is done by the only chemical school that is entitled to a respectful notice), we convert what is a simple problem, like all other processes of nature, into the greatest paradox that has been yet devised by the ingenuity of man. It is in vain to say that some one or two of the products of organization, such as carbonic acid, and urea, are such as result from chemical affinities, since these are excrementitious; while chemistry assures us that all organic compounds are utterly different in their elementary combinations from any compound of a chemical nature.

Thus might I go on to argue this subject upon general principles alone; while at every step of the argument, we should see the whole chemical hypothesis of life taking its proper rank as a dream of the imagination, or as a project of ambitious minds.

362. Digestion having been assumed to be more or less, or altogether, a chemical affair, it rationally followed that it might be imitated by art. Accordingly, when this ambitious science had succeeded in turning the whole inorganic world into the laboratory, it set itself at the manufacture of organic compounds, and even at the entire animal. It did not, like Alexander, sit down and weep because it had no more worlds to conquer; but, like Shakspeare, having "exhausted worlds, it then imagined new." Even eminent physiologists, who should look with jealousy upon any invasions upon the laws of nature, especially upon such as it is their peculiar province to illustrate, began the manufacture of gastric juice by fire and acids, and metallic salts. We are thus presented by these philosophers with artificial compounds, of a most incongruous nature, and we are told that each one is the gastric juice; that each is capable of the same precise results as that universal product of animals, apparently the same in all, and elaborated from the blood by an organ of the highest vital endowments, and to which there is nothing analogous in all the other products of living beings, each product being, also, equally unique, and all derived from one common source (§ 135 *a*, 316, 419, 827 *b*).

363. A diversity of opinions exists as to the real nature of the chemical agent supposed to be employed by nature in the process of digestion. Free muriatic acid having been found, or supposed to exist, in the stomach, it has been concluded by many that this must be the great agent; while Dr. Prout, and others, affirm that "free muriatic acid more or less retards the process of reduction." Dr. R. Thompson, however, states that, by digesting muscular fibre in dilute muriatic acid, he produced a substance "exactly resembling chyme." This experiment was pretty widely repeated, and many were equally successful with "dilute muriatic acid" as was Dr. Thompson. Others, on the contrary, declared their failure, and others, like Dr. Prout, maintained that this acid retarded digestion. Eberle had already advanced the hypothesis that mucous membranes, no matter whether of the stomach or the bladder, dissolved either in muriatic or acetic acid, would form the true gastric juice, and perform its wonderful operations. There is now a general bias in favor of one of these compounds, though other preparations are supposed by many to form very good gastric juice. Again, it is said that the "digestive mixture," as it has been well denominated by the manufacturers, "retains its solvent properties for months," while the gastric juice loses its solvent power soon after its abstraction from the stomach (§ 341). And what equally establishes a total difference between the "mixture" and the gastric juice is the no small circumstance that the chemist may torture and extinguish the artificial "digestive principle" in a variety of ways, and then transmute it back in all its vigor. Thus, according to Schwann and Müller, the artificial "digestive principle" may be neutralized by an alkali, and afterward "precipitated from its neutral solution by *acetate of lead*, and obtained again in an active state from that precipitate by means of hydro-sulphuric acid." This precipitate, we are told, when thus treated, and thus compounded of principles radically different from the original mixture, is essentially the same as the gastric juice, and that the results of such artificial preparations must be taken as the test of the *physiology* of natural digestion; that, abandoning nature, we must look to the resources of the laboratory for any satisfactory account of her vital processes. Nor do I at all exaggerate; for it is distinctly avowed that we knew nothing of digestion till the invention of the artificial mixtures. Thus, it is said of Schwann by one so able and distinguished as Müller, that he (Schwann) "having discovered that the infusion of dry mucous membrane with dilute acid, even after it is filtered, still retains its digestive power, the digestive principle, *therefore*, is clearly in solution, and *the theory of digestion by contact falls to the ground*." Here, a most important physiological induction is wholly founded upon a process which has not the most remote connection with organized matter.

364. I have said that the experimenters took the hint of manufacturing gastric juice from the occasional discovery of an acid in the stomach. But, this is undoubtedly a rare phenomenon in a healthy stomach, and where the food has been at all appropriate in quality and quantity. The chemical hypothesis, as I have said, was long ago in vogue, and was put at rest by demonstrative proof. Distinguished observers, Hunter, Haller, Willis, Spallanzani, Fordyce, and more recently Dumas, Schultz, and others, insist that the reputed acid is the result of a true chemical decomposition of vegetable matter.

Spallanzani, whose experiments were almost endless, Scopoli, Chevreuil, and others, rarely succeeded in finding it at all, and in some animals never. Spallanzani, indeed, affirms that the gastric juice is neither acid nor alkaline in its natural state.

As far back as Haller's day, when this subject was agitated, it is said by this illustrious and accurate observer, that, "although there may be some rare signs of an acid in the stomach, it does not, therefore, become us to suppose that food is animalized by a chemical process; much less to compare this process with the action of an acid." And, anticipating the modern experiments with the "digestive mixture," he declares of analogous proceedings at his own era, "frustra etiam quisquam, imitatus liquores acres chemicos, liquorem corrodentem invenerit, qui carnem in pultem resolvat." And there can be no doubt that Hunter's prophecy holds good to this day, that,

"If ever any matter is formed in any of the juices secreted in any part of a vegetable or animal body similar to what arises from fermentation, we may depend on it, it arose from that process; but we may also depend on it, that there is a defect of the living principle in these cases."

These are not the mere speculations of genius, but the facts and the conclusions of genius after a long, and wide, and experimental survey of nature. And are these observations, nay, our own experience, our own senses, to be set aside to accommodate an hypothesis of life which identifies dead, even inorganic, with living beings?

364½. But perhaps even a greater violence, than the foregoing manufacture of gastric juice, has been recently done to physiology, in the alleged conversion, by chemical manipulations, of the secreted products of organs, totally unlike, into each other. It should be conceded, however, that this has been generally sanctioned by the journals of the day. Thus, in the LONDON LANCET for July, 1845, is a quotation from the report of MM. Villefranche and Barreswill to the French Academy on the "*Chemical Phenomena of Digestion*," from which the conclusion is deduced that

"Thus, *it appears easy to transform the gastric juice, the pancreatic fluid, and the saliva, into each other, and* TO MAKE AN ARTIFICIAL GASTRIC JUICE FROM THE PANCREATIC FLUID, and *vice versa*"*!*

It appears, also, from these late experiments, that the digestive principle depends on an organic matter, that "the said matter may be destroyed by an elevated temperature," and that "its digestive powers vary, according as it is associated with a fluid having an acid or an alkaline reaction."

It would seem, therefore, not improbable that a new hypothesis will soon be in vogue, and that the acid principle will be abandoned to satisfy the claims of new aspirants.

365. The assumed identity of the artificial products with the chyme of the human and other stomachs has never been shown in the slightest degree; and that it is the merest assumption, is not only proved by what I have already set forth, but is fully admitted by those who advocate the chemical doctrine. The conclusion rests upon the mere appearance which the artificial substance offers to the eye. Thus, it is lately said by Dr. Davy, that

"It is impossible to witness the change which takes place in muscular fibre, in consequence of *putrefaction* giving rise to a fluid very

like chyme *in appearance*, without asking, may not PUTREFACTION be concerned in digestion itself, according to the earliest theoretical notions on the subject," and as now maintained by Liebig, and his followers (§ 350)? Farther on, however, in the same work, he says, "*twenty* different semi-fluids might be mentioned, to which, as far as the eye can judge, this putrid matter bears as close a resemblance as to *chyme*" (§ 341).

366. "Dr. Beaumont [of St. Martin celebrity] has instituted several experiments with a view to determine the power of acids in dissolving articles of food; and the results which he obtained, although they varied somewhat according to the substances employed in the experiments, have nevertheless led him to the conclusion that *no other fluid produces the same effect on food which the gastric juice does, and that* IT *is the only solvent of aliment*" (§ 341, 373).—MULLER'S *Physiology*, p. 589. *London*, 1839.

So far Dr. Beaumont's accuracy may be readily admitted. But, as his observations upon the natural process of digestion, as carried on in St. Martin's stomach, have become incorporated in most of the subsequent works on physiology, and even in systematic works on diet, where they generally serve as a foundation for some of the most important conclusions in the science of life, and have been seized upon with avidity by the supporters of the physical and chemical doctrines, and without any reference to their credibility, or to the unnatural condition of that celebrated stomach, it may be well to show, by their conflict with universal experience, that those observations are not only worthless, but pregnant with the greatest practical errors. For this purpose, it is only necessary to present a brief abstract from the tabular view supplied by the author of the average time occupied by different alimentary substances in undergoing digestion. Thus:

ARTICLES OF DIET.	*Mean Time of Chymification.*	
	Preparation.	h. m.
Pigs' feet, soused	boiled.	1 00
Tripe, do.	do.	1 00
Salmon trout, fresh	do.	1 30
Apples, sweet	raw.	1 30
Cabbage, with vinegar	raw.	2 00
Hash, meat and vegetables	warmed.	2 30
Goose	roasted.	2 30
Cake, sponge	baked.	2 30
Pig	roasted.	2 30
Pork, fat and lean, recently salted	raw or stewed.	3 00
Pork steak	broiled.	3 15
Sausage, fresh	do.	3 20
Dumpling, apple	boiled.	3 00
Green corn and beans	do.	3 45
Bread, wheat, fresh	baked.	3 30
Do. Indian corn	do.	3 15
Eggs, fresh	boiled.	3 30
Oysters, fresh	stewed	3 30
Beef, fresh, lean, rare	roasted	3 00
Mutton, fresh	do.	3 15
Fowls, domestic	do. and boiled.	4 00
Potatoes, Irish	boiled.	3 30

Here, then, we have pigs' feet nearly four times as easy of digestion as baked bread, or roasted mutton, or beef, or domestic fowls, or eggs, or oysters; raw cabbage nearly twice as easy of digestion; roasted pig and goose a third or more easier, &c. And these are

common examples of what is known, in medicine, as "the experimental philosophy of the nineteenth century," and "the march of medical science" over all former and more rational experience (§ 18).

367. The experiments with *pepsin*, or the artificial mixtures, have been limited to substances already animalized, in their simple conditions, and in minute proportions. Hay, nuts, onions, and even arrow-root, would be appalling to *pepsin;* and the quantities of the gormand, or the variety of the epicure, would soon show the nature of this branch of "experimental philosophy."

368. A chemical dilemma presents itself. The supposed chemical agent in digestion should be the same in all animals, to explain, in the least, the identity of the resulting products,—and so it is admitted by the advocates of one "mixture," or of another, respectively. But this, on the other hand, is clearly contradicted by the variety of the "mixtures," and by the vast variety of alimentary substances, consumed by different species of animals; while, indeed, if the least regard were paid to the laws of chemical affinity, it should be obvious that there would be no small variety of chemical influences in the stomach of omnivorous man.

369. Nevertheless, if the "digestive mixture" be made from the mucous tissue of the stomach of a strictly graminivorous animal, or even from its bladder, it will "digest" meat and other substances which form the peculiar food of carnivorous animals, but will refuse to digest most of the substances common to the animal from whose stomach the "digestive mixture" is prepared. This, therefore, is contrary to nature.

370. Digestion is well performed and often promoted when alkalies are taken into the stomach in sufficient quantities to hold the reputed amount of acid in a neutral state.

371. On the contrary, digestion is always impaired by the introduction of acids into the stomach while the process is going on.

372. Did the supposed acid exist in the gastric juice, it would render the medicinal doses of the nitrate of silver, or the acetate of lead, perfectly inert. This principle is also of obvious application to many other substances. Indeed, it would be a perpetual "incompatible" with many remedial agents.

373. If digestion depend on the supposed chemical agencies, the stomach should always undergo more or less of that change after death; especially violent death. It is the rarest phenomenon, however, in man or animals, to witness the slightest change in that organ that can be referable to the gastric juice (§ 366).

374. It is fundamental in nature that an organ which is designed for the production of an organic fluid does not also generate an inorganic substance, especially a simple element like chlorine, for the purpose of bestowing organization and life.

375. Again, since it is the mucous tissue of the stomach alone which, in all animals, secretes a juice capable of producing chyme; and as no other part of any organized being can generate a substance of similar power, how arrogant, therefore, the supposition that art can manufacture a fluid of the same virtues (§ 323–325)!

376. As new aspirants enter the field, novelties, of course, will spring up. They serve, however, to show us the importance of regarding with suspicion whatever may conflict with the long-establish-

ed conclusions which have been drawn from an observation of the most common phenomena of living beings. This leads me to advert to the experimental researches of Dr. Schultz, the eminent Berlin professor, which, whatever be their foundation, effectually destroy our confidence in all those "digestive mixtures" which have figured, of late years, so conspicuously in nearly all the systematic works on physiology.

In the first place, Professor Schultz infers that neither the stomach nor the gastric juice have much agency in digestion, but that this great office is mostly performed by the saliva. This distinguished observer also finds that,

1st. "The secretions of the stomach are always *alkaline* excepting during the process of digestion."

2d. "No food undergoes digestion without saliva."

3d. "The chyme is not produced by chemical action, but is an organic compound formed by a vital transformation of the food."

4th. "There is no such product as the supposed acid gastric juice; only a sour chyme" (§ 364, HUNTER).

5th. "The acid found in the stomach is the result of a chemical decomposition of the food" (§ 364).—SCHULTZ, *de Aliment. Concoctione.* Also, the *Rejuvenescence of Man*, &c. 1842.

Again, still more recently, M. Blondlot, under the guidance of "experimental philosophy,"* affirms that the saliva is of the nature of mucus, little else than the waste of organs (*as Liebig regards the gastric juice*, § 350), contributing nothing to digestion, and only useful as a shield to the mucous surface (BLONDLOT, *Traité de Analitique de la Digestion*, p. 124, 126).

376½. It appears, therefore, that all the prevailing physical views of digestion, the chemical doctrines of secreted products, the healthy and morbid processes of living beings, the modus operandi of morbific and remedial agents, which completely shuts out the magnificent laws of sympathy, and the whole bathos of the humoral pathology, have been, in recent times, the work of the laboratory. Physiologists and therapeutists, the British especially, appear to have forgotten that it is their business to explore the facts and the laws of organic nature, and to have turned the whole matter over to the chemist (§ 349, *d*). They have surrendered this high calling to the laboratory, and have bowed in submission to whatever its acids and crucibles have pretended to reveal as to the processes and laws of living beings. A vast number have thus discarded their lofty pursuits, and have substituted for them a most unnatural dependence upon the laboratory of the chemist.

The chemist has seized the opportunity with avidity; since his employment with inorganic nature is mostly analytical, mostly exhausted, while that which relates to living beings supplies an unbounded field for the institution of great principles and laws, whether true or false, and for the highest renown in philosophy. It is not remarkable, therefore, considering the prizes are few, the competitors many, that the "race is to the swift, and the battle to the strong," that the ambitious chemist should abandon the mere work of analysis, and push his inquiries into that magnificent department of nature where the richest laurels may be gathered. Inorganic chemistry supplies no such opportunities. Its work is analytical, and its principles few and simple;

* An artificial fistulous opening in a dog's stomach (§ 366).

and this, alone, is the legitimate object of organic chemistry. That object has been lately well expressed by Mr. Hoblyn, in his *Manual of Chemistry.* Thus:

"The peculiar principles which exist in all organized beings are distinct from those which operate on inorganic matters, and may be denominated *organic agents.* Their mode of operation is mysterious. *The object of organic chemistry is to investigate the chemical history of* the products which occur in the vegetable and animal kingdoms, and which are hence called *organic substances.*"

I therefore say, let us look well to the doings of the chemist. Let us properly regard his tampering with so profound a subject as physiology, whether in its natural or morbid aspects. Let us scrutinize his facts when he assails the experience of all the renowned in medical science through all past time, and declares that experience worthless (§ 350, *mottoes*). Let us not, however, indignantly retaliate upon him his attempts to overthrow the great fabric of medicine, or his efforts to undervalue the labors and the doctrines of men who have toiled in the field of organic nature, and have immolated themselves in the chambers of the sick. Let us rather kindly advise the chemist to cultivate modesty, and tell him, frankly, that, to comprehend the laws and the processes of living beings, they must be perpetually the objects of profound study, both in the natural state of the being, and in all the variations to which he is liable from the influences of morbific and remedial agents. Let us tell him that he has acted wisely in refraining from all such observations, and in making the laboratory the exclusive theatre of his experimental inquiries. Either science, analytical, and limited in principles and laws, as chemistry may be, is enough for the compass of an individual; and medicine transcends the powers of the most gigantic mind. The physician, therefore, if he aim at the highest practical usefulness, or at the science of medicine, will find only the leisure to acquire the outlines of chemistry, and it is equally certain that the chemist who aspires at a profound knowledge of that department, must spend his days and his nights within the precincts of his work-shop.

And now let us remember, that there is not one name in all the annals of medicine which rests for its distinction on the physical and chemical doctrines of life. On the contrary, in every instance where attempts have been made to carry the science of chemistry into physiology, in all, and every such instance, the individuals who have been so employed have sunk rapidly into oblivion; unless here and there a name, like Fourcroy's and Liebig's, which is rescued by lofty genius, and by purely chemical labors in the inorganic kingdom.

376¾, *a.* Finally, I will not forego this opportunity of bringing to the support of opinions which I have hitherto advanced, the following extract from Judge STORY's late address before the Alumni of Harvard University. It will be seen that the views of this distinguished man are entirely coincident with those which I had expressed in a former work. (See *Medical and Physiological Commentaries,* vol. i., p. 331–333, 310, 307, 308, 327, 385–400; vol. ii., p. 666–677, 801–815, 12, 13, 203, 644, &c.)

"I have said," says this eminent jurist, "that the tendency in our day is to ultraism of all sorts. I am aware that this suggestion may appear to some minds of an easy good-nature, or indolent confidence,

to be over-wrought, or too highly colored. But unless we choose voluntarily to blind ourselves to what is passing before our eyes in the daily intercourse of life, it seems to me impossible not to feel that there is much which demands severe scrutiny, if not serious alarm. I meddle not here with the bold, and yet familiar speculations upon government and polity, upon the fundamental changes, and even abolition of constitutions, or upon the fluctuating innovations of ordinary legislation. These might, of themselves, furnish out exciting themes for public discussion, if this were a fit occasion to introduce them. I speak rather of the interests of letters—of the common cause of learning—of the deep and abiding principles of philosophy. Is it not painfully true that the spirit of the age has broken loose from the strong ties which have hitherto bound society together by the mutual cohesions and attractions of habits, manners, institutions, morals, and literature? It seems to me, that what is old is no longer a matter of reverence or affection. What is established, is not on that account esteemed positively correct, or even salutary or useful. What have hitherto been deemed fundamental truths in the wide range of human experience and moral reasoning, are no longer admitted as axioms, or even as starting-points, but at most are propounded only as problems, worthy of solution. They are questioned and scrutinized, and required to be submitted to jealous proofs. They have not even conceded to them the ordinary prerogative of being presumed to be true until the contrary is clearly shown. In short, there seems to me, at least, to be abroad a general skepticism—a restless spirit of innovation and change—a fretful desire to provoke discussions of all sorts, under the pretext of free inquiry, or of comprehensive liberalism. And this movement is to be found not merely among illiterate and vain pretenders, but among minds of the highest order, which are capable of giving fearful impulses to public opinion. We seem to be borne on the tide of experiment with a rash and impetuous speed, confident that there is no risk in our course, and heedless that it may make shipwreck of our best hopes, and spread desolation and ruin on every side, as well on its ebb as its flow. The main ground, therefore, for apprehension, is not from undue reverence for antiquity, so much as it is from dreamy expectations of unbounded future intellectual progress; and, above all, from our gross over-valuation and inordinate exaggeration of the peculiar advantages and excellences of our own age over all others. This last is, so to say, our besetting sin; and we worship the idol, carved by the cunning of our own hands, with a fond and parental devotion. There are many even among the educated classes, and far more among the uneducated, who imagine that we see now, as men never saw before, in extent, as well as in clearness of vision; that we reason, as men never reasoned before; that we have reached depths and made discoveries, not merely in abstract and physical science, but in the ascertainment of the moral and intellectual powers of man, and the true structure and interests of government and society, which throw into comparative insignificance the attainments of past ages. We seem to ourselves to be emerging, as it were, from the darkness of by-gone centuries, whose glow-worm lights "show the matin to be near, and 'gin to pale their ineffectual fires," before our advancing radiance. We are almost ready to persuade ourselves that their experience is of little value to us; that the

change of circumstances is so great, that what was wisdom once, is no longer such; that it served well enough for the day, but that it ought not now to be an object of desire, or even of commendation.

"Nay, the comparison is sometimes eagerly pressed of our achievements in literature with those of former ages. Our histories are said to be more philosophical, more searching, more exact, more elaborate than theirs. Our poetry is said to surpass theirs in brilliancy, imaginativeness, tenderness, elegance, and variety, and not to be behind theirs even in sublimity, or terrific grandeur. It is more thoughtful, more natural, more suggestive, more concentrative, and more thrilling than theirs. Our philosophy is not, like theirs, harsh or crabbed, or irregular; but wrought out in harmonious and well-defined proportions. Our metaphysical systems and mental speculations are (as we flatter ourselves) to endure forever, not merely as monuments of our faith, but of truth; while the old systems must fall into ruins, or merely furnish materials to reconstruct the new—as the temples of the gods of ancient Rome serve but to trick out or ornament the modern churches of the Eternal City. Ay, and it may be so. But who will pause and gaze on the latter, when his eyes can fasten on the gigantic forms of the Coliseum, or the Pantheon, or the Column of Trajan, or the Arch of Constantine?

"May I not stop for a moment, and ask if there is not much delusion and error in this notion of our superiority over former ages; and if there be, whether it may not be fatal to our just progress in literature, as well as to the permanent interests of society? I would not ask those who entertain such opinions to accompany me back to the days of Aristotle and Cicero, whose works on the subject of government and politics alone have scarcely received any essential addition in principles or practical wisdom, down to this very hour. Who, of all the great names of the past, have possessed so profound an influence and so wide an authority for so long a period? If time be the arbiter of poetical excellence, whose fame is so secure as that of Homer and Virgil? Whose histories may hope to outlive those of Thucydides and Tacitus? But I would limit myself to a far narrower space, to the period of the two centuries which have elapsed since our ancestors emigrated to America. Survey the generations which have passed away, and let us ask ourselves what have been their literary labors and scientific attainments? What the productions of their genius and learning? What the amount which they have contributed to meliorate the condition of mankind—to lay deep and broad the foundations of Theology, and Jurisprudence, and *Medicine*—to establish and illustrate the principles of free governments and international law—and to instruct as well as amuse the leisure, and to refine the taste of social life? Unless I greatly mistake, a calm survey of this whole matter would convince every well-balanced mind, that if we may claim something for ourselves, we must yield much to the scholars of those days. We shall find that much of our own fruits have been grafted on the ancient stocks. That much of what we now admire is not destined for immortality. *That much which we deem new is but an ill-disguised plunder from the old repositories. And that much which we vaunt to be true consists of old fallacies, often refuted and forgotten*, or of unripe theories, which must perish by the wayside, or be choked by other weeds of a kindred growth.

"*The truth is, that no single generation of men can accomplish much of itself or for itself which does not essentially rest upon what has been done before.* Whatever may be the extent or variety of labors and attainments, much of them will fail to reach posterity, and much which reaches them will be felt, not as a distinct formation, but only as component ingredients of the general mass of knowledge. Many of the immortals of one age cease to be such in the next which succeeds it; and, at best, after a fitful season of renown, they quietly pass away, and sleep well in the common cemetery of the departed. What is present is apt to be dazzling and imposing, and to assume a vast importance over the distant and the obscure. The mind in its perspective becomes affected by the like laws as those of the natural vision. The shrub in the foreground overtops the oak, that has numbered its centuries. The hill under our eye looms higher than the snowy Alps, which skirt the edge of the horizon.

"But let us subject this matter to a little closer scrutiny, and see if the annals of the last two centuries alone do not sufficiently admonish us of the mutability of human fame, as well as that of human pursuits. What a vast amount of intellectual power has been expended during that period, which is now dimly seen, or entirely forgotten! The very names of many authors have perished, and the titles of their works are to be gathered only from the dusty pages of some obscure catalogue. What reason can we have to suppose that much of our own labors will not share a kindred fate? But, turning to another and brighter part of the picture, where the mellowing hand of time has touched with its finest tints the varying figures. Who are there to be seen but Shakspeare, and Milton, and Bacon, and Locke, and Newton, and Cudworth, and Taylor, and Barrow, not to speak of a host of others, whose works ought to be profoundly studied, and should illustrate every library. *I put it to ourselves to say, who are the men of this generation to be brought into comparison with these, in the extent and variety of their labors, the powers of their genius, or the depth of their researches?* Who of ourselves can hope to exercise an influence over the human mind as wide-spread as theirs? Who can hope to do more for science, for philosophy, for literature, for theology, than they? I put the argument to our modesty, whether we can dispense with the products of their genius, and wisdom, and learning; or may cast aside their works, as mere play-things for idlers, or curiosities for collectors of the antique?

"I have but glanced at this subject. It would occupy a large discourse to unfold it in its various bearings and consequences. But the strong tendency of our times to disregard the lessons and the authority of the past must have any thing but a salutary effect upon all the complicated interests of literary as well as social life. It not only loosens and disjoints those institutions, which seem indispensable to our common happiness and security, but it puts afloat all those principles, which constitute, as it were, the very axioms of all sound philosophy and literature. In no country on earth is the danger of such a tendency so pregnant with fearful results, as in our own; for it nurses a spirit of innovation, and experiment, and oscillation, which leaves no resting-place for sober meditation or permanent progress. It was the striking remark of an acute observer of the human mind, that 'he who sets out with doubting, will find life finished, before he

becomes master of the rudiments;' and that he who begins by presuming on his own sense, has ended his studies, as soon as he has commenced them."—*Judge* STORY'S *Address*, &c.

376¾, *b*. In parting, for the present, with organic chemistry, I would again pay my humble tribute to a science of exalted worth, in its vocation of laying open the constitution and laws of inorganic nature, and in applying its results to many of the most useful purposes of life. The physiologist venerates the science, does homage to its cultivators, would do battle for its cause. In protecting the great Institution which it is his province to illustrate, in preserving unsullied the stupendous philosophy of Medicine, he makes no encroachment on a sister science; but, ever obedient to the voice of Nature, he worships in all her temples.

4. DISTRIBUTION.

377. The fourth function common to animals and plants is distribution or circulation. In the former, after the food has become so far assimilated as to receive the final act of appropriation, or, in other words, after it is formed into blood, it must be distributed to all parts of the body, for their growth, nutrition, &c. This office is performed by the heart and blood-vessels in all perfect and superior animals, and by the blood-vessels alone in the inferior tribes, and whenever the heart is wanting. In the last instance, the means are very similar to those which carry on the circulation in plants.

378. The mechanism of circulation is shown by the function. In the perfect animals, the blood is expelled by the left ventricle of the heart into the aorta, and thence distributed to all parts of the body; where it is applied to nutrition and secretion, and undergoes depuration by the excretory organs. Such as is not thus appropriated is sent forward to the communicating veins, by which it is conveyed to the right auricle, and from thence to the right ventricle, to be distributed to the lungs through the pulmonary artery, and returned, again, to the left ventricle through the pulmonary veins and left auricle. In the lungs, the venous blood is converted to arterial, and perfected for the various exigencies of organic life, by the joint agency of the pulmonary mucous tissue and atmospheric air (§ 419, 827 *b*).

379. A remarkable exception occurs to the foregoing general plan of the circulation, in the transmission of venous blood from the abdominal viscera to the liver, through the vena portæ. It is also anomalous, that this blood is appropriated, in part, to the formation of an organic fluid, the bile, while the residue is transmitted to the vena cava through the hepatic veins; these veins being also the associate medium for the return of blood from the hepatic artery.

380. There are three principal distinctions between the blood sent out by the left ventricle and that which is returned to the right: 1st. The color of venous blood is a modena red; that of arterial a bright scarlet. 2d. Venous blood is more highly charged with carbonaceous matter than the arterial. 3d. Venous blood will not support the life of organs.

381. The blood supplies all parts with their means of nutrition, secretion, &c., and is, itself, the stimulus by which its own circulatory organs are excited to motion, and by which the formative and secretory vessels are maintained in their action. The *pabulum vitæ* is,

therefore, remarkably distinguished from all other substances in nature, in being equally the stimulus of the whole circulatory system, and the substance acted upon and appropriated according to the nature of every part in which it may circulate (§ 136).

It is the same with the sap of plants as with the blood; both being alike the *pabulum vitæ.* Each is every where converted into the solid organs to which it is distributed, and into fluids and other products which have their special allotment in organic life; and nothing is formed which is not derived immediately from the blood or sap (§ 41–44, 847 *c*).

OF THE POWERS WHICH CIRCULATE THE BLOOD.*

382. Much of the philosophy of medicine is involved in a right estimate of the powers which carry on the circulation of the blood. But, having set forth this subject extensively in the Medical and Physiological Commentaries, I shall now limit my remarks to a statement of the most prominent facts (§ 407, *a*).

383, *a*. A great error has prevailed of ascribing the circulation of the blood to the propelling power of the heart alone. Another, less common, imputes venous circulation to the action of the capillary arteries; while a still greater regards it as a hydrostatic phenomenon dependent on the arterial column of blood. Another, subversive of all principles in medicine, refers the circulation in the capillary vessels—those instruments of all the essential organic processes—to capillary attraction. Another supposes that the blood is moved in virtue of its own inherent power. Another, that the globular portion is composed of animalcula, which traverse the circulatory system by their locomotive endowment. But, the most obnoxious to objection is the latest speculation which flows from the universal doctrine of Liebig, that

"All vital activity arises from the mutual action of the oxygen of the atmosphere and the elements of the food;" that "the life of animals exhibits itself in the continual absorption of the oxygen of the air, and its combination with certain component parts of the animal body;" and that "the cause of the state of motion is to be found in a series of changes which the food undergoes in the organism; those changes being the results of processes of decomposition, to which the food itself, or the structures formed from it, or parts of organs, are subjected." (See § 350, nos. 9, 10.)

This last hypothesis imputes the circulation entirely to the chemical action of oxygen gas upon the tissues and upon the blood itself; rejects, altogether, the propelling and suction power of the heart, overlooks the respiratory movements, the peristaltic action of the intestinal canal, the permanent contraction of the sphincters, the motions of the iris, denies all vascular action, even in the face of such phenomena as blushing, and all other sympathetic movements, nor recognizes a local morbid physiological determination of blood, or a morbid process, or a physiological influence of therapeutical agents, but construes all these unique results upon the same chemical phenomenon.

383, *b*. A modification, however, of this doctrine concedes an instrumentality of the heart in circulating the blood. The heart still acts in virtue of the combustive process; and so far the doctrine is

* The term *powers*, as here employed, comprehends the instruments of circulation.

consistent. But it is fundamentally contradicted by the incongruity of the two great sources of power at the apex and at the circumference of the circulation, when contrasted with the exact balance which prevails between the moving power of the heart and the circulation of the blood in the capillary system. Nor is there to be found in nature two such distinct sources of power for the accomplishment of a specific effect as that which imputes the circulation of the blood to an associate mechanical impulse by the heart and a chemical process in the capillary blood-vessels (§ 129).

384. There are numerous elements concerned in the circulation of the blood, each one of which I have endeavored to substantiate in a former work.*

1st. The heart possesses, through its vital properties, an active power of dilating and contracting (§ 498, *e*).

2d. The arteries possess a similar power, though in a far inferior degree. This has been determined by the application of irritants.—(*Medical and Physiological Comm.*, vol. ii., p. 147–152, 375–403.)

3d. The capillary arteries, or the reservoirs of blood to the extreme vessels, have the same power, which is much more actively exercised than in the larger arteries. The capillaries are consequently brought into greater action when stimulated by physical agents, as in inflammatory diseases, or by the nervous power, as in blushing (§ 180, &c.).

4th. The extreme vessels, or terminating series of the arterial system, have, also, a like power of contracting and dilating actively, and in a still greater degree than the capillary arteries (§ 136, 750).

5th. The extreme capillary veins have, also, a special action of the foregoing nature, which aids in transmitting the blood from the arterial system to the next larger series of veins.

6th. The larger veins possess the power of dilating and contracting actively, according to the varying quantities of blood transmitted from the arterial system. Their constant *conatus* to contract on their contents assists in the transmission of the blood.

7th. All the cavities of the heart operate upon the principle of an exhausting pump, during their dilatation.

385. All the foregoing powers (§ 384) concur together, according to a consummate Design, in circulating the blood. All are important elements; no one adequate in itself, while each should be studied by itself, as well as in connection with the whole (§ 74, 80, 117, 137, 143, 155, 156, 169 *f*, 266, 303¼ *a*, 306, 310, 311, 387, 399, 409 *f*, 422, 514 *h*, 524 *d*, 525, 526 *d*, 528 *c*, 638, 649 *d*, 733 *b*, 764 *b*, 811, 847 *c*, 848, 902 *f*, 905).

386. The contraction and dilatation of the heart and arteries are, respectively, nearly synchronous. Although there be a perfect consent of action between the capillaries, the extreme vessels, and the heart, those vessels are not associated with the movements of the heart, nor with each other, in the same way as the actions of the heart and arteries; and they are modified, also, according to the special functions they perform in different parts (133 *b*, 135 *a*, 136). The case of blushing shows us the law in regard to the capillaries (§ 476, &c.).

387. The final cause of motion in the veins is chiefly that of sub-

* Medical and Physiological Commentaries, vol. ii., p. 375–426, 147–152, and the Essay on the *Theories of Inflammation, ibid.*

serving the arterial system; and here the consent of action between the veins and arteries is still more illustrative of the profound nature of the principles and laws which govern the functions of organic life. It has been, indeed, the universal doctrine that the capacity of the veins is determined in a mechanical manner by the volume of blood transmitted from the arteries; but I have endeavored to show that the supposed physical distension and elastic contraction of the veins are without foundation, and would form a most serious obstacle to the circulation of the blood. On the contrary, it appears that those actions are not only of a vital nature, but that they are a perpetual illustration of sympathy, depending upon sympathetic relations of the veins to the communicating series of arterial capillaries.

This peculiar constitution of the veins explains the reason why they collapse when divided; since their sympathetic relation to the arteries is thus extinguished. The veins, indeed, appear to be not less susceptible of action from the stimulus of sympathy with the capillary arteries than the iris with the retina (§ 514, *k*), whose phenomena so clearly demonstrate the operation of that principle in developing sensible motions.

The dilatations and contractions of the veins are, therefore, very greatly effected by sympathetic influences exerted upon them by the varying states of the capillary arteries, as well as by the quantities of blood they are employed in transmitting to the veins. These influences appear to be originally felt by the capillary series of veins, where the organic properties are most strongly pronounced, and thence propagated by continuous sympathy to the larger series (§ 498, and *Comm.*, vol. ii., p. 520, 521, &c.).

Did not a consent of action with the arteries (depending on the principle of sympathy, § 452, 495, &c., 498) exist in the veins, the vital contractility, and the elastic property of the coats, must be mechanically overcome by the increased quantity of blood transmitted to them. The blood must be forcibly injected into the capillary veins by the *vis a tergo*, and in numerous parts which cannot be penetrated by the finest injections of art. This is utterly repugnant to that Unity of Design which prevails in all parts of the organized being, and would be leaving an important function to a fortuitous and inadequate provision. Nor can it be consistently supposed that the phenomena which appertain to one class of vessels are of a vital nature, and those of the other, resulting in an anatomically associated series, mechanical.

The veins possess, also, longitudinal fibres, by which they are fitted for rapid and uniform motion over an extensive tract; and this action implies a predominance of continuous sympathy (§ 498). It is also proved that the veins, like the heart and arteries, dilate actively on the application of certain stimuli to their external surface.—(*Med. and Physiolog. Comm.*, vol. ii., p. 147–152, 375–401.)

388. Venous circulation is determined principally by the suction or derivative power of the right cavities of the heart, but is aided by the contractile power of the large veins, by the more specific action of the capillary veins, and by the propelling power of the communicating series of arterial capillaries. The contraction of the left ventricle of the heart, and that of the large arteries, have little or no agency in venous circulation. Their force is probably exhausted, or

nearly so, when the blood has reached the terminal series of the arterial system.

The blood is returned from the lungs to the left cavities of the heart by the powers just stated.

It is not alone the dilatation of the auricles which constitutes the derivative power, as had been supposed till I investigated this subject; but equally, also, that of the ventricles.

389. In the Medical and Physiological Commentaries, I have examined every objection which has been alleged against the imputed dependence of venous circulation upon the dilatation of the cavities of the heart, and atmospheric pressure. One objection had been stated with greater force and apparent plausibility than the rest, by Drs. Philip, Arnott, and other eminent men; namely, that the parietes of the veins should collapse upon the supposed doctrine of suction. To this objection I have replied, that the injecting power of the communicating arterial capillaries maintains the veins in a state of fullness. The perfectly harmonious relation among the powers which circulate the blood establishes a correspondence between the movements in the venous and arterial systems, by which nature has duly provided against so great an evil as apprehended.

390, *a*. The suction power of the heart, as I have endeavored to show in the "Commentaries," is indispensable to the portal circulation, and to that, also, of the lymphatics, lacteals, thoracic duct, and umbilical vein; though, doubtless, the independent action of these vessels contributes to the motion of their contents.

390, *b*. In the foregoing work I have considered the objection relative to the occasional jet of blood from a vein wounded in venesection in certain conditions of disease; and I purpose now, from its ambiguous relation to my subject, adverting to the causes of the intermitting pulse that so often attends congested states of the liver. This phenomenon has been long observed; but no substantial cause has been assigned. It is due, I apprehend, to two influences, one of which is sympathetic, the other more or less mechanical.

The sympathetic is readily appreciated; the mechanical, and most important, requires explanation. In my Essay on Inflammation, and in the present work, I have endeavored to show that the current of blood is accelerated in the vessels immediately concerned in that morbid process, notwithstanding the enlarged diameters of the vessels (§ 711, &c.). But not so in venous congestion, unless the propelling, and therefore, also, the suction power of the heart, be considerably increased. It often happens, however, that the force of the heart, in venous congestions of the liver, is even reduced below its ordinary standard, however there may be an attendant hardness of the pulse (§ 688). Now, therefore, since the veins undergo an enlargement in their congested states, and since, also, the volume of blood which is transmitted to the heart through the portal system is very large, if it enter that organ in an unusual manner, it is highly probable that it would embarrass its action. Such would be the effect of a sluggish or irregular ingress, especially, as will be seen, if not correspondent with the egress of blood.

But, it not unfrequently happens that the pulse becomes intermittent, for the first time, after the hepatic affection has sensibly yielded. This occurs, however, mostly, if not altogether, in rather intense

forms of venous congestion, and where the force of the heart, and therefore its suction power, are manifestly increased, so much so, indeed, that practitioners, cautious of blood-letting, will venture upon the remedy. An incomplete subsidence of the disease, and the means of treatment, reduce the action of the heart; and the suction power being thus lessened, while the veins remain yet enlarged, the blood moves with a tardy pace in the portal veins, and disturbs the rhythmic action of the heart.

There is also another, and important element of this mechanical cause, which consists in an interrupted balance between the blood which enters the heart and that which is projected from it; its entrance being rendered slow by the state of the portal veins, while its projection is unembarrassed. If the pulse be merely intermittent, and only so after several beats, excitement from exercise, but not from the mind, will often restore, for a short time, the harmony of both ventricles. Moral excitement, on the contrary, through nervous influence, is apt to increase the intermission, and often adds an *irregularity* (§ 227, 509, &c.). But, unlike the simply intermitting, an *irregular* pulse is commonly increased in its irregularity by violent exercise, as well as by excitements of mind. The intermitting pulse, on the contrary, is often most strongly pronounced in the horizontal posture.

The nature of the *sympathetic* cause will be readily appreciated by the accurate observer, when he considers how often intermissions or irregularities of the pulse are increased by a full, and sometimes a scanty meal (§ 512).

Cerebral inflammation often gives rise to an irregular action of the heart; but here the cause is determined by the nervous power alone (§ 226, &c.). In the case of the brain, also, the pulse is apt to be more irregular than intermittent; while in that of the liver it may be both (§ 687, &c.).

391. The valves of the veins have been universally supposed to contribute essentially to venous circulation, by supporting the column of blood. This, however, I have endeavored to show, is a mistaken opinion;* for they are always open when the current of blood is passing. Like the valves of the heart, their great final cause is to prevent the reflux of blood when pressure operates, and to contribute to the like design of the frequent inosculation of the veins. The supposed co-operation of the voluntary muscles in venous circulation is also merely accidental.

392, *a*. It appears, therefore, that the whole theory of the circulation is strictly relative to the properties of life. The pressure of the atmosphere, by which the blood is forced along the returning vessels, is entirely incidental; and, although the transit of blood from one part to another is merely mechanical, its motion originates entirely in vital agencies. The facts, of which the foregoing conclusions are predicated, are very numerous, and contribute to some of the most important pathological and therapeutical principles. It may be useful to consider yet farther some of the most indisputable, and to regard them, at the same time, in their connection with the laws of which they are the foundation.

392, *b*. Although the vascular system contributes an important part

* Medical and Physiological Commentaries, vol. ii., p. 412, 426.

toward the common circulation, the heart possesses within itself a general control over this great function of life. Had it been otherwise, "a thousand causes might intervene, over which the organ, so limited in influence, could have no control, to retard or divert the course of the blood; and which, by occasioning one short delay, might prevent its return forever." It is, therefore, not only the great motive source, through its contractile power, in the universal act of distribution, but, to effect a return of the venous blood, "it is made the centre of atmospheric pressure and gravity, and designates the stage in the circulation in which a deficiency of supply would be the last in being felt. Hence it appears that the functions of the heart are performed, and life preserved, notwithstanding long and copious discharges of blood, which, upon any other hypothesis, must have been fatal. For, according to these hypotheses, the heart, or at least the auricles, are placed at the end of projection. They mark the highest advance of the tide, and would first be abandoned by the retiring fluid. They would be drained by every profuse hemorrhage, and the heart would expend its energy in fruitless efforts to circulate a fluid that came not within its reach." Upon any other theory, how could what Armstrong calls "the beautiful balance between the right and left sides of the heart" be preserved? How, otherwise, would the circulation be restored in syncope? In respect, also, to the absorbent power, it is farther well said by Carson, that, "though we are not acquainted with any data from which the power of the heart can be calculated, there must exist, nevertheless, certain limits, within which it must reasonably be supposed to be confined. If we consider that the quantity of blood in circulation is nearly one fifth of the weight of the whole body; that this great mass is spread over an immense surface; that it is therefore subjected to great resistance from friction, especially in the small vessels where each globule is to be rolled over a fixed surface; that the currents, in consequence of anastomosing branches, are perpetually flowing in opposite directions, and that attraction must powerfully prevail between the blood and small vessels; when we consider the mass moved, the motion with which it is moved, and the resistance opposed, it is impossible to imagine that this labor could have been performed by the propelling power of the ventricle;" besides the obvious objections of the liability of the curvature of the aorta and the capillary arteries to be ruptured, and the exigencies of the portal, placental, and lymphatic circulation (§ 390).

Again, "the two trunks of the ascending and descending cava meet at the heart in such a manner as to form a straight line. The streams of blood which are conveyed by these vessels to the heart are placed at that point in direct opposition. Upon the supposition that the blood is returned to the heart by a *vis a tergo*, this position of the vessels is the most unfavorable that can be conceived for the office that is assigned to them. The momentum of blood in one vessel would be destroyed by that of the other; or, if the current in the descending was stronger than that in the ascending cava, the blood in the weaker stream would be prevented from ever reaching the heart."

392, *c*. In the Medical and Physiological Commentaries, especially in the Essays on Inflammation, and the Powers which Circulate the Blood, I have exhibited a great amount of proof establishing the vital actions of the capillary blood-vessels, and showing that the mo-

mentum of the blood, as derived from the left cardiac ventricle, is nearly lost in the capillaries. The opinion of Hunter, Bichat, Philip, and other distinguished observers, to the same effect, being founded upon the most ample investigations, would seem to leave no doubt upon a question of such fundamental importance in the philosophy of organic life. "Have they," says Wilson Philip, "who maintain that the circulation is supported by the muscular power of the heart alone, made even the rudest calculation of the degree of resistance to be overcome in driving the blood through two capillary systems at such a rate, that, in a given time, the same quantity shall be delivered by the veins, which is thrown into the arteries? Have they made any estimate of the strength necessary in the different sets of vessels, and particularly in the larger arteries, to sustain a power capable of overcoming this resistance? Let them give what imaginable power they will, they cannot make this power greater than the coats of the vessels will bear without rupture."

So completely arrested, indeed, is the momentum of blood when it reaches the arterial capillaries, so manifest are the vital actions of these vessels, and so unaccountably did Philip and Bichat overlook the suction power of the heart, that they ascribed the circulation in the veins entirely to the propelling action of the capillary arteries. Owing to this limited view, Bichat was led to observe, that, "notwithstanding all that has been written as to the cause of venous circulation, there is an obscurity in it, in which there are but few rays of light." The circulation of the liver embarrassed him especially; since any general hypothesis which should fail here must be wholly abandoned (§ 390). He considered it, however, "incontestibly proved, that when the blood has arrived in the general capillary system, it is absolutely beyond the influence of the heart, and that the left ventricle has no influence in the venous system."

392, *d.* The demonstrations of a direct nature, to show the independent action of the blood-vessels (the veins as well as arteries), are too numerous and various for concentrated observation. They are scattered throughout this work, and many of importance occur only in the *Medical and Physiological Commentaries* (vol. ii., p. 147–152, 375–401). The original suggestions of many belong to myself, as, also, their general application to the subjects before me. It has been one of my special objects to demonstrate an active dilatation of all the blood-vessels, as well as their active contraction. The latter, indeed, proves that the dilatation is active and vital. The greater principle lies in the necessity of a counteracting power; since active contraction alternating with dilatation necessarily implies corresponding principles of motion, or there would be a permanent state of contraction or tonic spasm. The sanguiferous system, therefore, would be devoid of function, and nothing but "stagnation" would be the great law of organic nature (§ 748).

393. The doctrine of venous circulation, as I have expounded it here, and proved it extensively in the "Commentaries," is replete with the most important physiological, pathological, and therapeutical conclusions. It strikes a fatal blow at the whole mechanical hypothesis and the stimulant treatment of venous congestion (§ 788–793), as shown in my Essay on that affection. It determines all the great fundamental points which have been in dispute respecting the circu-

lation of the blood. It proves that the propelling force of the left ventricle of the heart is lost, or nearly so, in the extreme capillary arteries. It proves, what is of greater importance than all things else in the Institutes of medicine, that the extreme vessels possess an independent vital action; since otherwise the blood could never be carried forward in the veins by the power of suction (§ 389). But that would not be the greatest oversight in the plan of organic nature.

394. The highest practical, as well as philosophical, conclusions are involved in a correct estimate of the powers which determine the circulation of the blood (§ 393). But there are no errors so prolific of evil, and so derogatory to medical philosophy, as that which assumes a passive state of the terminal series of the arteries, or that circulation is carried on in that series by capillary attraction, or by their oxydation (§ 383).

Were either of these hypotheses true, there could be none of the organic products, as derived from the blood, no secretion, no nutrition—not a principle in physiology, pathology, or therapeutics; for all the essential organic functions, and all the processes of disease, are carried on by the terminal series of the arteries (§ 481 *g*, 483, &c.).

Consider the phenomena of sympathy; contemplate the experiments of Philip to determine the laws of the vital functions; study the laws of the nervous power in their relation to organic functions; observe how instantly mental emotions will variously affect the action of the heart, or bring a suffusion of blood to the pallid face, or how stimuli applied to the brain will as instantly produce corresponding results (§ 481–485); and you will concede that these results of the operation of the nervous power demonstrate the independent vital action of the capillary vessels, and overturn the physical and chemical hypotheses of life.

395. The foregoing influence of the cerebro-spinal and ganglionic systems upon the capillaries and extreme vessels is of the highest importance in pathology, and in the philosophy and treatment of disease. These vessels are not only the instruments of disease, but they sustain all the morbific influences which result in sympathetic diseases, and upon these vessels all remedial agents exert their curative effects, whether by their direct action, or through the instrumentality of the nervous power (§ 222–233$\frac{3}{4}$, 456 *a*).

396. Nor is it alone an active condition by which the terminal series of arteries is remarkably distinguished. Our various facts establish the no less important principles, that the several orders of terminal vessels have their vital properties and actions strongly pronounced, and that these properties and actions are peculiarly modified in their natural state, both in a general sense, and in different parts, and that they are liable to various other peculiar modifications from the operation of morbific and therapeutical agents. Hence, all our curative means must have a steady and direct reference to the existing condition of these extreme capillary vessels (§ 149, 150, &c.).

397. Of the extreme vessels physiologists have supposed, with great reason, that there are at least three series; one being destined for nutrition, another for the secretion and excretion of the fluids, and another series coinciding with the veins.

Without being disposed to submit this question, in the least, to the

microscope (§ 131), there might be allowed, according to Wagner, what has probably been hypothetically suggested by the well-known simplicity of nature, that there is "but one kind of termination in reference to an artery—a passage into a vein through a capillary vessel, and an intermediate net-work." In this case, however, there must either exist lateral projections from the terminal capillary, or there must radiate from the "intermediate net-work" vessels whose office is to carry the white blood, from which are eliminated the materials for nutrition, &c.

398. The extreme vessels which are destined for nutrition, secretion, and excretion, elect from the blood, contained in their reservoirs the capillary arteries, the precise elements that are necessary to the formation of each peculiar compound throughout the body, and in such uniform proportions and modes of combination as shall forever, and without deviation, render them exactly conformable to the nature of every part, as ordained at the Creation (§ 41–44). This is done in virtue of the peculiarly modified states of irritability and other properties of life, according to the exact office of every part. Yet are these the vessels which are said to be under the sole government of physical and chemical laws (§ 383), and whose morbid state in inflammation is constituted by a mechanical relaxation of their parietes, and a stagnation and coagulation of their contents (§ 711, &c.)!

399. In their natural state, the foregoing vessels refuse admission to the red globules of blood, in virtue of their peculiarly modified irritability; and this, therefore, where the calibre surpasses the diameters of the red globules. There is no mechanical "*straining off* of the finer from the coarser parts of the blood" by an inadequate capacity of those vessels which convey only white blood (§ 493, *d*). The separation is effected in a homogeneous substance, and by causes which are very foreign to "strainers" and "sieves" (§ 129, 135–138, 266, 649 *d*). The same principle interprets the admission of the red globules into those serous vessels, in inflammation. Irritability is there morbidly affected, and the usual process of vital decomposition of the blood is, of course, arrested (§ 327–329). The entire blood then finds its way into the lymph vessels, as they are called; and the organic law by which that result is determined (§ 192, 278) is beautifully illustrated by two experiments; one by Buniva, the other by Procter. The experiments also confirm the doctrines which I have taught as to the character of the nervous power, and its agency in organic actions, while each observer pursuing different routes, and attaining a common end through opposite effects, but by common principles relative to the nervous power, illustrate and confirm the experiments of each (§ 222–233¾, 476, &c., 500).

Buniva had great difficulty in effecting an injection of an artery of a living dog, till he divided the spinal cord, when, by thus withdrawing the stimulus of the nervous power, the capillaries lost their peculiar susceptibility, and the contents of the syringe passed freely on.—Buniva.

In Procter's experiment, "a horse was killed by dividing the medulla, the bowels turned aside, and the branch of the sympathetic nerve, which joins the ischiadic, laid bare; also, one of the arteries of the leg. A wire applied to the positive pole of a galvanic battery, defended with sponge, was applied to the nerve, and the nega-

tive wire to the artery. The positive wire was then drawn slowly along the plates of a fifty-plate battery, and the effect was certainly not only to reproduce the pulsation in the artery, but also clearly to excite circulation in the more minute vessels." A by-stander exclaimed, "See how that pipe beats when they put on those wires!" —PROCTER, *on the Sympathetic Nerve.* 1844.

To the foregoing may be added the experiment by Dr. Hall (§ 263), which, it will have been observed, is insuperably opposed to his conclusions as to the agency of the nervous system in producing organic actions, and as examined in my Essays on "Vitality," &c. (p. 42, *note*). See, also, Experiments by Kriemer, § 485, and Philips, § 483, and Dr. Parry's case, § 487, *gg*.

5. APPROPRIATION, OR NUTRITION AND SECRETION.

400. APPROPRIATION, like assimilation, is a comprehensive, though less complex, function. It embraces what are commonly designated as two functions, namely, nutrition and secretion.

401, *a*. A common fluid being formed, and distributed to the several parts of the animal and vegetable, is then appropriated to their several uses.

401, *b*. Animals are distinguished by an unceasing change of the materials of which they are composed. The actions of life disturb the composition of parts, which, being thus unsuited for the purposes of organization, and reduced to a fluid state, are returned to the general circulating mass of blood, where they either again undergo assimilation, or are eliminated and cast off by the excretory organs. To supply this waste is, in part, the office of appropriation, which furnishes new molecules from the blood, in exact conformity with the process of disintegration after growth is completed, but occurring in excess while nutrition is engaged in rearing up the fabric to a state of maturity. Appropriation is also the function through which those secreted fluids, which act as auxiliaries in the processes of life, are renewed in their original character.

402. Appropriation, therefore, whether it refer to the increase and renewal of the solid parts, or to the production of useful fluids, being equally a process of secretion, every organic product, vegetable or animal, is the result of secretion. But appropriation, as applied to the useful fluids that are formed from the blood or sap, is more commonly known as an act of secretion; and though the next function which will be considered, namely, *secretion*, is very analogous, yet the final causes of secretion and excretion being entirely different, it is proper that they should be arranged as distinct processes.

Since, however, nutrition, secretion, and excretion are very analogous processes, *secretion* is a good generic term for the whole. Each process consists of certain acts by which new formations are generated from the blood. All parts are first eliminated in a fluid state. Such as are destined for nutrition assume the condition of the solids which they supply as soon as eliminated; such as subserve the uses of fluids remain permanently fluid. It is evident, therefore, that appropriation, in a philosophical sense, is the highest act of assimilation, but may be very properly regarded as a function by itself.

403. Every part of the body possesses a secreting apparatus, since every part appropriates the blood to itself (§ 398).

404. The organs which generate the permanent fluid products are very various, and more complex than such as carry on nutrition. The former are either glands or simple membranes, acting in their compound condition (§ 92). The immediate instruments consist of a simple series of extreme vessels which pervade every part, and which are every where so constituted, anatomically and vitally, that they elaborate from the common nutritive fluid such compounds as are exactly conformable to the nature of each part respectively (§ 41–44, 133, &c., 135 *b*, 188, &c., 205, &c., 233, 397, 398).

405. The variety of secreted products, solid and fluid, is greater, and the quantity more abundant in animals than in plants, and in proportion, also, to the complexity of organization.

406. The following products of secretion which remain more or less fluid occur in the animal kingdom. The first six are common to most animals:

1. Gastric juice. 2. Saliva. 3. Pancreatic juice. 4. Bile.	Concerned in digestion.
5. Serous fluids.	Of the serous tissues. " cellular tissue. " articular tissues. " chambers of the eye. " capsule of the lens. " labyrinth of the ear.
6. Mucous fluids.	Of the mucous tissue of the mouth. " " " nose. " " " pharynx. " " " larynx and trachea. " " " lungs. " " " stomach. " " " intestines. " urinary and genital organs. " skin of aquatic animals.
7. Tears.	
8. Fatty or oily liquids.	Suet, and fat of cellular tissue. Marrow of bones. Liquids in the cryptæ of the skin. Cerumen of the ear. Fatty fluid of prepuce. Many other oily products.
9. Fluids of defense.	Ink of the sepia. Liquids of insects. Virus of serpents, &c. Galvanism of torpedo, &c.
10. Humors of the spider, and of other insects, from which their webs, cocoons, &c., are formed.	
11. Fluids necessary to the preservation of the species.	Germinal fluid. Semen. Product of vesiculæ seminales. Liquor of Cowper's glands. Liquids in the fœtal membranes. The milk of mammifera.

The foregoing fluids are variable according to the nature of the animal, but always the same in each species, and analogous, respectively, in all (§ 63, &c., 83).

407, *a*. In considering the mechanism and the function of appropriation, it devolves upon the Institutes of Medicine, as in all other anatomical and physiological inquiries, to apply the whole to the elucidation of the laws upon which the mechanism is founded, and under which the phenomena take place. It will still be my purpose, therefore, to interrogate the whole in their various relations, and to illustrate the philosophy of the whole by contrasting the defects of spurious systems.

407, *b*. The exact anatomical condition of the instruments of nutrition and secretion, as well as the functions themselves, can never be brought within the cognizance of sense; nor would it be of any practical use to know them beyond what is revealed by the vital and physical results (§ 83, 131). By these facts we are enabled to institute many of the most important conclusions in physiology. By them, especially, we demonstrate the errors of the physical and chemical doctrines of capillary circulation, and of the chemical and mechanical hypotheses relative to secretion. By them, we show that all the products from the blood, as well as effusions of blood in the ordinary forms of capillary hemorrhage, find their way out of the vessels through open orifices, and that the physical doctrines of percolation, and endosmose and exdosmose, have no foundation in organic nature (§ 131, 275).

407, *c*. It has been also seen by demonstrations in respect to the development of the ovum, that appropriation is conducted by the same powers throughout the life of the being that were brought into action by the stimulus of semen; and it may be now added that the coincidence is beautifully enforced by a progressive and uninterrupted march of that primary development, which was instituted in the ovum, after the beginning of independent life (§ 63–81, 153–159).

408. The mechanical doctrine of filtration, which supposes the incalculable variety of secreted products to exist already formed in the blood (§ 41), still disfigures the physiology of the schools, and forms a prominent characteristic in the prevailing pathology of inflammation. To the whole of this subject, as well as to the chemical hypotheses, I have given an extensive investigation in my Essays on the Humoral Pathology, on the Vital Powers, on the Theories of Inflammation, on Endosmose and Exdosmose, and on Diabetes, as embraced in the Medical and Physiological Commentaries. Many remarkable assumptions, intended to sustain the physical rationale of vital processes, are there examined and refuted. But, the explosion of one error, it has been said, often prepares the way for another; as exemplified in the following quotation relative to the hypothesis of endosmose and exdosmose:

"This permeability to gases," says Liebig, "is a mechanical property, common to all animal tissues; and *it is found in the same degree in the living as in the dead tissue*."—LIEBIG'S *Animal Chemistry*.—See, also, § 350.

409, *a*. When considering the subject of proteine in a former section (§ 18), I reserved for this place all that was not immediately relative to elementary composition. What was there set forth should be

applied in connection with what I shall now advance in continuation of the subject.

409, *b*. We have seen that, in opposition to the received doctrines as quoted from Liebig in section 18, there is nothing in the secreted products of animals, solid or fluid, that subsist on vegetable substances similar to the food, except in elementary composition, nor in the blood itself; while it is also affirmed by Liebig, that "*analogy, that fertile source of error, has unfortunately led to the* VERY UNAPT COMPARISON of the *vital functions of plants with those of animals.*" But the reader, who may have attended to the parallel columns, and the sections on the chemical hypotheses of disease and therapeutics, will be neither surprised at the inconsistencies now and formerly indicated as to the prerogative of the vegetable kingdom in doing the whole work of assimilation, and even trespassing upon that of appropriation, in behalf of the animal tribes, nor unprepared for a farther explosion of the doctrine by its principal author. Let us, therefore, hear the chemist yet farther in his contradiction of the great fundamental doctrine (§ 18). Thus:

"We must not forget," says Liebig, "that, in whatever light we may view the vital operations, the production of nervous matter from the blood presupposes a change in the composition and qualities of the constituents of blood. That such change occurs is as certain as that the existence of the nervous matter cannot be denied. In this sense, we must *assume* that from a compound of *proteine* may be formed a *first*, *second*, *third*, &c., *product*, *before* a certain number of its elements can become constituents of the nervous matter."

Again, having in view another special point, we are told that

"This much, at least, is undeniable, that the herbs and roots consumed by the cow contain no butter; that in hay, or the other fodder of oxen, no beef suet exists; that no hog's lard can be found in the potato refuse given to swine; and that the food of geese or fowls contains no goose fat or capon fat;"—"that as yet no trace of starch or sugar has been detected in arterial blood, not even in animals which had been fed exclusively with those substances."—(See *Comm.*, vol. i., p. 674–682.)

And what gives special plausibility to these speculations is the controversy which has taken place between "the Reformer" on one side, and Dumas and other French chemists, on the other, respecting the origin of *fat;* the former maintaining that it results from transformations of sugar, starch, and other "vegetable proximates," while the latter contend that not only this, but agree with Liebig that all the other unique products of herbivorous animals are formed without the aid of their complex assimilating organs,—that they are merely applied as generated by the plant. In this latter doctrine is also seen a striking display of the human mind to run into simple views of nature; overlooking all the complicated facts and the whole labyrinth of animal organization, and making the ultimate sustenance of animal life but one remove from the constituents of the atmosphere (§ 303$\frac{1}{4}$, 304, 305, 322).

And again, when chemical demonstrations cannot be resisted,

"We *must admit*," says Liebig, "as the *most important* result of the *study* of the composition of gelatinous tissue, and as a point *undeniably established*, that, although formed from compounds of *proteine*,

it *no longer belongs* to the series of the compounds of *proteine. No substance* ANALOGOUS to the tissues yielding gelatin is found in vegetables."

Nay, not even in the blood itself; though,

"It is *conceivable* that membranes and tissues which yield gelatin are formed from albumen by the addition of oxygen, of the elements of water, and those of ammonia, accompanied by a separation of sulphur and phosphorus. *At all events, their composition is* ENTIRELY DIFFERENT *from that of the chief constituents of the blood.*" "But there is no doubt that these tissues are formed from the constituents of the blood"! Q. E. D.—LIEBIG'S *Animal Chemistry.*

It will be thus seen that the chemist is finally coerced to the admission that many of the most important organic compounds depend altogether upon the specific action of organs by which they are elaborated from the blood, and that he is even embarrassed with a "doubt" whether "these tissues are formed from the constituents of the blood." This is all the vitalist desires. It betrays the factitious nature of the whole physical rationale. It proclaims that every secreted product is different from the common source of supply, and different in every part of the animal. Chyme differs from chyle, and blood from either. Each differs in every species of animal, from man down to the white-blooded tribes; yet each, wherever existing, is forever the same in the same species. And so with plants, even with such as seek for ammonia and nitrates upon the dung-hill, or others that gather iodine from the deep (§ 289, 350, nos. 26½, 77). Each product, therefore, is generated in its unique characteristics by agents and processes which are designed specifically for the formation of each. Nor would this be doubtful to any observer who may pass along the various gradations of the assimilating organs from their simple condition in plants to that complexity which demanded the superaddition of the nervous systems (§ 336).

If we take, now, the premises on which the chemist proceeds to the exact conclusions which he sets forth in his formulæ of organic compounds, those who have been inattentive to his method will be surprised at its destitution of all but vague conjecture, where organic compounds are concerned; and, for the unique nature of these compounds, the reader must turn to what I have said on the subject of *Composition.* The following is the great starting point:

"The organs are formed from the blood, and contain the elements of the blood. They become transformed into new compounds with the addition only of oxygen and water. Hence the relative proportion of carbon and nitrogen must be the same as in the blood.

"If, then, we subtract from the composition of blood the elements of the urine, then the remainder, deducting the oxygen and water which have been added, must give the composition of the bile.

"Or, if from the elements of the blood we subtract the elements of the bile, the remainder must give the composition of urate of ammonia, or of urea and carbonic acid"! Q. E. D.—LIEBIG'S *Animal Chemistry.*

Such, once more, is the basis of organic chemistry, with all the apparent precision of mathematics, in its extraction of a cube root; yet never the same in its analysis of the *elementary* composition of the blood, avowing the homogeneous nature of that compound of 17 or

18 elements, and, finally, in the very midst of its mathematical accuracy, allowing that there is no one organic compound elaborated from the blood by the *living* similar to the results of *artificial* processes. This I have already abundantly shown, even in the present section, and in another relative to it (§ 18). The same evidence abounds in the parallel quotations (§ 350), and a glance at the "*Animal Chemistry*," or the "*Organic*," would supply other facts for my present purpose. Thus, in the following sentences, enough is conceded to substantiate my position; and it is worth the specific remark that "we know with certainty" that albumen and fibrin have not the same composition.

"We must be careful not to deceive ourselves in our expectations of what chemical analysis can do. We know, with *certainty*, that the numbers representing the relative proportions of the organic elements are the same in *albumen* and *fibrin*, and hence we conclude that they have the same composition."

"If we reflect, that from the *albumen* and *fibrin* of the body all the other tissues are derived, it is *perfectly clear* that this can only occur in *two* ways. Either certain elements have been *added to*, or *removed from*, their constituent parts," and so on.—LIEBIG'S *Animal Chemistry*.

409, *c*. If the viper be fed exclusively with any one substance, its peculiar poison will be generated; and so of the characteristic products of the civet, the cuttlefish, the skunk, the beaver, &c.; each, also, being always generated by one particular part. Here, then, are tests for an important and comprehensive philosophy. From these we may descend along a scale, where we shall find in some of the secreted products of every animal and plant certain prominent characteristics which declare that not only these, but the less striking, also, are as much dependent on special organization, and special powers and actions, as the poison of the viper, or the fœtor of the skunk, or the civet, or the beaver, or the ink of the cuttlefish, &c. Will any thing in nature, excepting the mucous tissue of the stomach, produce a substance at all analogous to the gastric juice? Is there any thing analogous to semen in the blood? Can it be generated by any thing but the testis (§ 83, *b*)? Can it be surmised that it is at all the product of forces which govern the inanimate world? Consider the nature of granulations, so obvious to the eye, and yet so analogous to the products of nutrition. From whatever parts of the body they spring up, they have all, originally, the same appearance. The same in bone as in muscle. But, so various are the modifications of their vital constitution, that they ultimately elaborate substances exactly conformable to the nature of the tissues, respectively, by which the granulations were generated. We know that there must be specific powers to effect these results, and that in each tissue, and in the granulations thereof, the powers are modified; and we know, also, that the results defy all explanation by any chemical or mechanical laws.

409, *d*. Carry the same principle to morbid conditions. Is not the virus of hydrophobia generated exclusively by the salivary glands, and by those glands in a particular state of disease, and probably, also, by the canine and feline tribes alone? Does not every morbid product require a specific mode of disease? Is not this distinctly exemplified in scarlatina, measles, small-pox; and, therefore, equally true

in less striking cases? Equally as true of common pus as of the pus of variola? And here I would refer to what I have said, in my Essay on Inflammation, of the nature and formation of pus;* how its formation is indiscriminately imputed by the same philosophers to a spontaneous alteration of blood in the large vessels, to chemical actions in the small, and to the decomposition of dead animal matter; how its analysis has led different chemists to opposite conclusions both as to its nature and formation; and how it is affirmed by the chemist to be unchangeably the same, whether the product of an abscess, of a chancre, or of the variolous pustule. The confusion in these respects is very remarkable, showing the perfect inadequacy of the principles by which the explanation is attempted; while they, who believe that animated nature operates by other forces, see nothing but admirable simplicity, and a fountain of the highest practical advantages to mankind.

409, *e*. Again, do we not find remarkable relations between the structure of secreting organs and the matter secreted (§ 346)? Where organization is most complex, the secretions are most compounded, and, as the structure becomes more and more simple, so also do the corresponding secretions. And yet, in the most simple membranes, apparently of the same organization, the products, according to Cuvier and others, are almost as various as the different species of animals, consisting of fluids in some, and of air in others; yet always the same in each species. On the other hand, what complexity of organization in the liver of the higher animals; yet all is precise, harmonious, and adapted to specific ends. Those ends, and that complexity, are fatal to all the chemical and physical views of the functions of assimilation and appropriation. And yet is the secretion of bile, which, according to the chemists, is composed of forty different compounds, and these made up of four or five elements, compared to what is supposed to be a chemical evolution of carbon from the blood; and the liver is also said, by distinguished physiologists, to be merely an "abdominal lung." We are told that "physiologists have been induced to suppose that the structure of the kidney is such that it allows the urea to percolate through the fine vessels emptying into its pelvis, like the mechanical operation of *sifting* or *filtering*, but denies a passage to the other constituents of the arterial blood." But how "deny" them; why do they never escape; why do not the constituents of the bile come this way, and *vice versa?* Is it more difficult for one substance to "sift and filter" its "passage" through one set of vessels than the other? The iatro-mechanical, it is true, are comparatively few with the iatro-chemical philosophers. The latter have also greater zeal. They are more recently in a field full of seductive novelties, and other allurements, while pure chemistry can offer nothing but the details of analysis.

409, *f*. All the secreted fluids have not only an apparatus peculiar to each, whose complexity corresponds remarkably with the compound nature of their products, but they are all destined for important specific ends in the economy of living bodies; a final purpose of which chemistry and physics are wholly incapable. One would be perfectly unsuited to the office of another, and would be even destructive of life, in most of the cases, should one product interchange with

* In *Medical and Physiological Commentaries*, vol. ii., p. 181–204.

another (§ 129, 135–137). The saliva, gastric and pancreatic juices, are designed for digestion; the blood being thus an almost direct cause of its own reproduction (§ 323–325, 356 *a*). The bile subserves three specific purposes, which, when regarded in their connection, supply one of the most remarkable instances of Design. This fluid participates directly in the assimilation of food, is the important cause of peristaltic motion, and performs, lastly, that inferior office, which is often regarded as its only one, of contributing with the lungs, kidneys, and skin, as an emulgent of the blood, though in a different aspect from the organs of excretion (§ 415, 423). The products of the serous membranes are designed, for the most part, to facilitate organic and voluntary movements; mucus serves, like the cuticle, to protect its organ against offending causes, &c.; the "humors" of the eye, and of the internal ear, are media of communication between external objects and the nerves of sensation; and they are wonderfully adapted to the laws which they are intended to subserve. The semen, milk, fat, animal heat, &c., are other remarkable examples of final causes which secretion is intended to fulfill. To these might be added many others, less important, but not less to our purpose; as the poison of snakes and of insects, the galvanism of aquatic animals, the ink of the sepia, the fluid from which the spider builds his house, and with which we cure intermittent fever, &c. And, when we regard, in connection, the bile, the gastric juice, semen, milk, &c.—all derived from the homogeneous blood,—and consider the uniformity of their respective composition in health, their changes according to the alterations of the vital properties in disease, and these changes corresponding with certain modifications of the vital phenomena, are we not moved with astonishment at the total difference in their nature? Is there any relief for our astonishment but in a firm reliance upon powers that are equally unique in their operation? Would not amazement otherwise increase, till it should prove that the human mind does not rightly interpret the laws of nature, and is unjust to its own endowments?

409, *g*. If we now survey the vegetable kingdom, we shall find all things constituted upon the same plan. The poppy, digitalis, croton, spurge,—every thing growing side by side in the same earth, the same air, and watered with the same fluid, have, each one, its unique and unvarying sap and secreted products; an infinite variety of precise combinations derived from about four simple elements (§ 41, 42). Again, also, not only different species of plants when flourishing in the same soil yield different products throughout, but the same species have produced, from the day of their creation, the same identical products, in all their parts, in every variety of soil and climate. And so of all animals, whatever the variety of food. In the vegetable kingdom, we are also amazed at the systematic Design manifested in the coincidences between the various elementary combinations and their virtues as vital stimuli, or as morbific or remedial agents, which obtain among numerous species of many genera of plants, and which are maintained in all the varieties of soil to which the plants may be subjected. But, while these analogies prevail among the medicinal properties of certain extensive groups of plants, the products of each species, and of the several parts of the same species, have certain peculiarities, and these, too, will depend, in many plants, upon the stage of their advancement toward the flowering season, while they are not influenced by soil, climate, &c. (§ 52, 155).

409, *h*. Apply what has now been said of the products from the sap of plants to the formation of blood alone, which is composed of about the same elements, and we see how vain the attempts to explain by chemical laws even the formation of chyle; its conversion even from a white to a deep red color, and yet that color changing to white again under the influence of slight disease; and, finally, the vitality with which the blood is endowed. And, notwithstanding the complexity of the human body, its endless variety of food, and its artificial combinations and changes, has not the chemist given us a standard of the composition of the chyle, the blood, the gastric juice, bile, saliva, milk, &c., by which their morbid changes are to be tested in all countries, at all seasons, at all ages of man and of the world? Has he not told us that all this is so uniform in the natural state of the animal, so unlike the results of chemical agencies, that when changes arise they are indicative of changes in health? And does he not offer to show, that this alteration of the blood and secretions is so uniform under the same circumstances of disordered health, that you may tell by it the nature of disease and the appropriate remedy (§ 5, 5½ *a*)? Is not this the basis of practical humoralism? I grant the fact as to the relation of specific changes in the secretions, the blood, also, and specific modifications of action. But is not all this in absolute opposition to whatever is known of the capricious operation of chemical forces? And what shadow of proof is there, that these vital powers, which the chemist now and then invokes to his aid, are not entirely adequate to the physiological results that are ascribed to the forces of chemistry? And having also just reminded the reader that the elementary composition of the blood and sap is about the same in all animals and plants, he can hardly be prepared to believe that they are the same thing, either in a general sense, or as it respects the individual species in either department of the organic kingdom.

409, *i*. And now, turning again to the mere physical theorist, if there be any who cannot appreciate the objections which I have set forth to their peculiar views of secretion, let them appeal to their ordinary habits of observation, and look at the condition of the blood as reputedly laden with the various compounds which are supposed to be strained off from the great vital fluid. What an unphilosophical mixture! All the forty ingredients of the bile into which that homogeneous substance is separated by the various manipulations of the chemist,—all the variety into which the urine is resolved by the same ingenious devices,—mucus, saliva, gastric juice, albumen, gelatin, cerebral substance, fat, tears, sweat, milk, semen, the germinal fluid, &c.,—nay, more, all the peculiar compounds which go to the formation of the different parts of the body; and each one, and no other, strained off by that part alone which has been forever engaged in the individual office of eliminating one exact compound, or one special variety of compounds. Nor is this the end of the absurdities; for the same physical doctrine supposes that this principle is coextensive with the vegetable kingdom, and that every species of plant and animal embraces in its circulating fluid special varieties, which, in the aggregate, make up the many millions of specific and unvarying compounds of which the organic kingdoms are composed (§ 41). Nor is it a small part of the difficulties which surround the mechanical and chemical hypotheses of secretion, that all these millions of compounds

are liable to exact variations, according to morbid changes in the parts by which they are elaborated.

409, *j*. Is the chemical hypothesis of *catalysis* better calculated than the mechanical to resolve the great problem which concerns the formation of the millions of unique products from one common fluid, and in conformity with the facts which have been hitherto stated? This doctrine is, doubtless, the most ingenious of any which has been advanced by chemistry; but it has little to sustain it even of the specious analogies supplied by inorganic processes. Indeed, so little is *catalysis* supported by the phenomena of inorganic nature, that its existence is denied by many able chemists. Thus:

"Liebig," says Mülder, "has been led to reject *catalysis* entirely, and to give a totally different explanation of facts. He has *assumed*, that chemical forces are in action in those substances which, according to the supposition of Berzelius, are capable of exciting action, though without taking part in that action; and he thinks that by such chemical action, another may be excited in other substances. He adopts the principle, indicated by La Place and Berthollet, that a molecule, being put in motion, can communicate its motion to others, if in contact with them. He applies this principle to yeast especially," &c.—MULDER'S *Chemistry of Vegetable and Animal Physiology.*

In section 350¾, *d*, is a brief statement of the catalytic theory as advocated by Mülder; and in the Medical and Physiological Commentaries (vol. i., p. 55–78) I have considered specifically the obstacles to its application to organic processes, while it must encounter, also, all that I have here alleged against the mechanical and other physical doctrines. Nor is it the least objection to the whole chemical system of organic life, that the two principal leaders in organic chemistry "*give a totally different explanation of facts*," that make up the essential attributes of living beings. Mülder affirms that Liebig's theory is an "assumption," while Liebig "*rejects entirely*" the catalytic theory of Mülder. The medical reader will easily appreciate the worth of Liebig's "assumption," by referring to its attempted "explanation of facts" as revealed by disease. (See § 350, *nos.* 40, 41, 42, 44, 45, 350¼.)

It has been hardly worth while to advert particularly to the hypotheses which assign to electricity and galvanism an agency, more or less extensive, in the formation of the secreted products, or which regard the nervous system as the source and conductors of that fluid, or which identify galvanism with the nervous power. Enough is here said, as also of the phenomena of the nervous power (§ 222–239, 500, &c.), to evince the absence of all connection of organic processes and results with electrical or galvanic influences. In the Medical and Physiological Commentaries, however, I have critically explored the whole subject (Essay on the Vital Powers, and its Appendix).

410. We may therefore well conclude that there is nothing so important in the whole compass of physiology, and in the philosophy and practice of medicine, as a proper understanding of the vital constitution, in their properties and functions, of those extreme vessels by which nutrition and secretion are performed. Those are also the instruments of all morbid processes, and those by which all morbid products are elaborated from the blood. And since all healthy products are clearly the result of processes to which there is nothing anal-

ogous in the world of dead matter, how obviously must all the products of disease, all those of inflammatory conditions, which vary but little from the natural standard, be owing to the same vital processes of those formative and secretory vessels somewhat diverted from their natural states, and in which deviations disease must be allowed to consist (§ 750).

411. Finally, the function of appropriation is that which evinces, more than any other, the existence of a vital principle. This principle, being admitted as the basis of that function, must be carried to every other process of living beings. It is by appropriation that the new elementary combinations, in their endless variety, are formed from the blood or sap. By nutrition, which begins at the earliest development of the embryo in the aspect of growth, under the government of a peculiar power, as admitted by all, the organic being is carried forward to full maturity, and maintained while life continues. At every stage of his existence, it is the same process as that which was started by the impression of the semen upon the germ; and, since no new results are brought forth, no new powers can be called into operation. The living semen is the first stimulus of the organic properties of the embryo, and in this respect it is analogous to those vital stimuli which forever after maintain the same powers in action, and by which the same nutrition, or the same elementary combinations, are effected at every subsequent stage of existence. By nutrition, through the operation of these vital properties, and according to specific plans instituted by the Creator, and to be forever perpetuated by the substituted energy of the vital principle, all those forms of organic beings, which pass by almost insensible gradations from the mushroom up to the gigantic tree, and from the microscopic animalcule to the majesty of man, are maintained in all their exact peculiarities, in all their analogies to each other, in all their vital and moral attributes. It is by nutrition, that is to say, by the specific modes in which some three or four principal elements are united together, and joined to pre-existing parts of the same nature (§ 41, 42), that each animal or plant, according to its species, acquires and maintains a specific configuration and organization, exhibiting vital results that are peculiar to each, producing specific germs that are developed in exact conformity with the nature of the parent, and each pursuing forever a certain path which was marked out for itself alone by the Hand which gave it existence. Such, and far more, is the *wonderful power*, a power substituted for the *Creator Himself*, which directs capillary circulation, and governs the process of nutrition in the development of the embryo, in the maturity of the being, and in the perpetuation of the species.

Briefly, then, the whole essential philosophy of organic life, all that is important, or useful, or dignified in medicine, is directly relative to the vital constitution, and the vital actions of the formative and secretory vessels. *Here is the labyrinth of life, here of disease, here the ultimate aim of medical philosophy.*

6. EXCRETION.

412. Excretion is the sixth grand function common to animals and vegetables. It is analogous to secretion, and is performed by analogous organization; though the differences in these respects are probably greater than between nutrition and secretion, in their ordinary acceptation (§ 402, 404).

413. By excretion useless matter is elaborated from the blood and ejected from the body. The results of this function, therefore, are entirely different from those of secretion, which are destined for useful purposes in the animal economy.

414. The terminal series of the arterial system, as with appropriation, are the immediate instruments of the function of excretion. But, like secretion, a compounded organization is necessary to excretion. In this respect there appears to be about the same anatomical variety allotted to secretion and excretion (§ 404). The same tissue, indeed, and even the same part, may perform both functions; as in the lungs, and in the uterus (§ 135).

Notwithstanding, however, these coincidences, the final causes of excretion and secretion are so very different (§ 413), the processes which give rise to such opposite results should be regarded as different functions.

415. The difference between secretion and excretion, as denoted by their respective uses, is confirmed by the elementary constitution of the products of these functions; those of secretion being organic, those of excretion inorganic. There is also reason to believe that special elementary changes take place in the urine soon after its elimination from the blood.* Urea may be also artificially produced; and such is unquestionably the fact when chemically formed out of blood, or even from the urine (§ 53, *b*).

416. The principal excreted substances are, 1st. *Carbon;* 2d. *Sweat;* 3d. *Urine.* The lungs, skin, and kidneys, are the organs by which they are elaborated. The lungs and skin exercise their function, principally, after nutrition and secretion have been performed, and are, therefore, mainly concerned in excreting the waste parts of the body; though this devolves also upon the kidneys, especially in disease.

417, *a*. No one of the foregoing products is of an organic nature; and the supposed triumph of the chemist in manufacturing urea is no more a proof of the dependence of organic compounds on chemical processes than the formation of carbonic acid. The sweat and the urine being liable to transformations as soon as elaborated (§ 415), and more especially as every chemical agent by which their analysis is attempted necessarily changes their composition, their actual condition at the moment of their production can never be known. Such, also, is true of the analysis of every organic compound. The very analysis supposes the generation of compounds or of elements in artificial modes; but the original compound being the product of the organic powers, the transformation of its elements, whether spontaneous or effected by the chemist, and through certain agencies, occurs in certain determinate modes, and according to the influences which had been impressed by the organs of life (§ 54, *a*). Besides, it is now fully admitted that many very uniform and remarkable formations out of organic compounds, and themselves, too, allied to organic substances, have no such natural existence; as hydrocyanic acid, narcotin, &c. (§ 42, 409). Even Magendie threw in the way of proximate analyses the conclusive fact that, "during the short transit from the vascular tubes to your receiver, the component elements of the blood are found to effect a new arrangement."

* See *Medical and Physiological Commentaries*, vol. i., p. 526, 585, 602, 675–679.

417, *b*. When, therefore, I may speak of changes in the "component parts" of organic compounds, I refer either to such as may be wrought by organic processes, or by influences exerted by less obvious causes, as in the case of the bile (§ 316), or to those chemical transformations of a specific nature which depend upon chemical agencies (*a*).

418. Carbon is the greatest excrement of animals, and is evolved from plants. In the former it is effected by the mucous tissue of the lungs, and often by the skin (§ 135); in the latter by the leaves (§ $303\frac{1}{4}$).

419, *a*. The excretion of carbon by the lungs is construed by the chemists according to their rules of interpreting other organic actions. But, as I have endeavored, in the "Commentaries," to establish the vital character of this phenomenon, I shall only now advert to its philosophy, and in connection with that which respects the production of animal and vegetable heat (§ 433, &c.). They are thus associated by myself out of regard to the confusion which has befallen them in the hands of the chemist. But, appealing to him who sees in organic nature its plainest contradistinctions from inorganic, I would, in this place, submit to his understanding whether it be not probable that the same philosophy attends the elaboration of carbon by the lungs and by the skin, and whether that function of the skin in many animals be not as much an organic process as the associate secretion of sweat?

419, *b*. But, if the foregoing analogies be not sufficiently conclusive, consider, next, the elaboration of that excrementitious matter, the urine; which all but the purely physical philosopher recognize as a vital process. And, again, shall it be admitted that, while nature has constituted the pulmonary mucous tissue, like that of the stomach, intestine, bladder, &c., upon her universal plan of organization, and endowed it with the vital function of generating mucus, she has stepped aside in an isolated part of one and the same continuous tissue to introduce, along with the vital, a chemical function? It is the same argument as derived from the production of sweat, in its connection with carbonaceous matter; and here the analogy brings into cooperation every product of the living being, and establishes the whole upon common principles.

419, *c*. There remains, however, a demonstration from analogy which is perfectly irresistible. We have already seen how differently modified in their vital character are not only different tissues, and tissues of the same apparent organization, but even different parts of one and the same continuous tissue. We have seen this exemplified in a variety of aspects, and especially by the specific nature of the product of certain parts. We have seen, for example, that there is nothing in nature but that part of the gastro-intestinal mucous tissue which lines the stomach that will generate gastric juice, while, also, it produces mucus (§ 133–136). Now, carry this to another part of the same continuous tissue which lines the air-cells, and the inference is plain that if the gastric juice be elaborated by a vital process, so also is the carbonaceous matter. Nor can any objection be urged that other parts of the mucous system do not contribute to the function of decarbonization upon the ground that they are less delicate, and therefore less permeable to the air, than the mucous portion of the lungs, since, in some animals, that dense organ, the skin, performs the same office. Nor is there a better chance for the application of en-

dosmose and exdosmose, since atmospheric air is often in contact with the mucous tissue of the stomach.

420. Perspiration or sweat, which is sensible and insensible, being elaborated by an organ of highly complex organization, is clearly a product of organic actions; and since the skin of some inferior animals, like the mucous tissue of the lungs, eliminates both mucus and carbon, this coincidence of function in two very complex organs may be considered worthy of some regard in forming the logical induction to which the facts in the preceding section may seem entitled.

421. The excretion of urine is the next great source of depuration to the blood. Like the other products of excretion, it contributes to the process of assimilation by its depurating effects (§ 416). It is astonishing, too, with what rapidity many substances appear in the urine after their admission into the stomach; often not more than five or ten minutes intervening. This rapidity of excretion is particularly true of all matter which is offensive to the organization.

422, *a*. There is a remarkable sympathy subsisting between the kidneys and skin, by which, as it were, they interchange functions with each other. We are all familiar with the fact that the urine is most abundant in cold weather, and the perspirable matter most deficient, and *vice versa;* and, as a general principle, when one excretion abounds, the other is lessened. This is true in disease as in health (§ 129).

422, *b*. For the fulfillment of their final cause, the kidneys possess an exquisite susceptibility to the influence of the nervous power (§ 188, &c., 226, 528 *b*). Hence arises the rapid and profuse excretion of urine when fear and certain other emotions of the mind are in operation. The same affirmation, too, may be made of the skin, though perhaps less extensively. This, too, is the reason why fear so readily induces copious sweats. In either case, the phenomena are owing to the direct development and determination of the nervous power upon the organs, respectively. These phenomena, too, prove the great susceptibility of the skin and kidneys to the influence of the nervous power, and are a key to the whole philosophy of the interchanges of action between the skin and kidneys (§ 129, 230).

But there are, also, as may be inferred from the facts just stated, great sympathetic relations between the skin and kidneys and many other organs, though these relations are much more manifested by effects which arise sympathetically in the excretory organs than by the influences of these organs upon other parts. This is mostly seen in disease, and during the operation of remedial agents applied to the stomach. So great, indeed, is the snsceptibility of the skin and the kidneys, in their excretory function, to remedial agents, that a large variety have received the denomination of sudorifics, and another class, diuretics. But, owing to the special vital constitution of the skin and kidneys, by which they are rendered sensitive in their excretory function to a thousand slight influences, it is obvious that the foregoing denominations of remedies convey hypotheses that are unfounded, and of injurious tendencies. There are no better sudorifics than fear and hot water; no better diuretic than impending danger (§ 246, 500, &c.).

422, *c*. In respect to the foregoing principle as shown by diseased conditions, the facts are not less familiar. In such cases, an organ

which is naturally designed for secretion may sometimes, by a morbid increase of its products, take on the relative function of excretion, and thus, both by morbific sympathetic influences, and by copious elaborations from the blood, diminish or suspend the excretion of urine. In the cholera asphyxia this excretion would fail entirely, even when the profuse intestinal discharges were unattended by the usual perspiration. But, in the case of the intestinal affection, much was due to the morbific, vital influences; since we often see the urine increased by the active operation of cathartics.* Scarcely a morbid state disturbs the organs of digestion without diminishing or increasing the effete products of the kidneys and skin, especially of the former organ. The kidneys, however, being designed for the mere purpose of depuration, do not hold a corresponding sway over the great organs of life, but mainly so as it respects their dependence upon those organs (§ 139); while a greater reciprocity of sympathy between the skin and the essential viscera of life, and a predominant sympathy between the skin and kidneys as organs of excretion, evince the wonderful nature of Design in its provisions and limitations, according to the final causes which directed the plan of organic life (§ 325).

423. How vain the attempt to refer any of the foregoing processes and results to any of the forces or laws which rule in the inorganic world! The entire rationale rests upon the peculiar operations of the nervous power, and the laws of sympathy (§ 222, &c., 435, &c., 455 *e*, 500). A balance of actions and products is thus perpetually maintained, though, of course, with less uniformity and exactness in sickness than in health. But nature, ever provident, has so constituted the properties of life, that when one organ, whether excretory or secretory, becomes morbidly suspended in its function, the evil will be felt by other organs, through the nervous power; and they will thus take on, as it were, the work of that suspended organ. If the excretion of urine be wholly arrested, not only the skin, but many other parts, may join in the concerted action of relief. But, no other part will ever excrete urine, no more than the skin will secrete semen.† The absurdity of this prevailing doctrine is shown, at once, by the fact that urine would excoriate the eliminating vessels of every part excepting those of the kidney (§ 83 *b*, 133, &c.).

Organs of pure secretion, however, may take on, in consequence of the foregoing condition, the office of excretion; that is to say, they will elaborate, along with their natural fluids, the excrementitious matters, in certain *peculiar* combinations, which, in the healthy state of the kidneys, would appear in the form of urine (§ 417).

424. The philosophy of all that I have now said in respect to the interchange of offices among the organs of secretion and excretion, and of the dependence of the several products upon special conditions of anatomical structure and modifications of the organic properties, is the same that is concerned in the process of lactation after parturition, however different the remote and final causes. The mammary glands sympathize with the new change in the uterine system, and produce a fluid which is totally different from the blood, although, like all other products, it is derived from that fluid. And, there

* See my work on the *Cholera Asphyxia* of New York, 1832.

† See *Medical and Physiological Commentaries*, vol. i., p. 526, 588, 603, 608, 680.

would be just as much wisdom in supposing that the sympathetic influence of the womb upon the mammary glands, at this critical juncture, is a chemical phenomenon, as there is in referring the elaboration of milk to the capricious forces of chemistry, while its reputed filtration from the blood, by others, is equally refuted by the sympathetic nature of lactation in every species of mammifera.

425. The excretion of urine, more than the products of any other part, may be affected by the absorption of unnatural agents into the circulation. This is because many agents, which will excite the action of the kidneys, are not offensive to the lacteals nor to the system at large, and are therefore freely absorbed. Such are many saline and alkaline substances, and others, again, which are natural to the body, as aqueous fluids, &c. Those being either unnatural or redundant, rouse the action of the kidneys, as the proper organs for their elaboration. The quantity of urine is thus increased; and, while the kidneys are thus stimulated, they may be rendered the means of excreting other matters, though in a very different condition from their existence in the blood (§ 408).

426. In morbid states of all the principal organs, the urine is remarkably liable to change. This arises from various causes. If the stomach be the primary seat of disease, or, if its condition be disturbed through sympathetic influences of other diseased organs, as is almost constantly the case, digestion is imperfectly performed, and the chyle, in consequence, becomes more or less unfitted for the purposes of nutrition and secretion. The kidneys, therefore, carry off more than their wonted quantity of excrementitious matter, while this matter appears under conditions more or less varied from the natural product (§ 325). The whole office of appropriation is, also, more or less impaired, which farther modifies the condition of the blood and the formative action of the kidneys; though a part of the office of excretion, under these circumstances, devolves upon the skin and lungs (§ 416). A third great cause of the variableness of the urine consists in unusual vital decomposition or wasting of the body, or of some of its parts, when it devolves upon the kidneys to co-operate, beyond their natural habit, with the lungs and skin, in removing the redundancy of waste materials. A fourth cause of the urinary changes, and an important one, lies in actual morbid states of the kidneys themselves. The kidneys, however, are not often the seat of morbid affections beyond those of a simple functional and transient nature, as induced by sympathetic influences exerted by the diseases of other parts; but to which influences the kidneys are extremely liable, and, therefore, to consequent modifications of the urinary product.

427. Briefly, then, every alteration of the natural action of the kidneys, whether primary or sympathetic, and every defect in assimilation and appropriation, is attended by some change in the urine; while an endless variety is imparted to it by the qualities and quantities of the ingesta. From this circumstance, which should have prompted other conclusions, has arisen the belief that the state of the urine supplies some of the most important signs of pathological conditions, not only of the kidneys themselves, but of remote organs with which they may sympathize. From Hippocrates to our day, elaborate disquisitions have appeared concerning the changes of the urine as indicative of particular forms of disease, of their special seats, of the dif-

ferent stages of their rise and decline, and of their degrees of severity and danger. The humoralists were apt to regard the unusual conditions of this product, and other "vitiated secretions," as the disease itself; and in this respect they are imitated by the humoralists of the nineteenth century. Chemistry has been also brought to bear upon the fluctuating states of the urine, and has increased the factitious importance of a symptom which is often as likely to denote some alimentary substance, or divers forms of disease, or imperfect digestion, or some remedial agent, as the source from which it emanates.

But, coming to the bed-side, we find that all these critical observations are relics of the superstitious ages of humoralism. Here, we find that all that is practically useful in relation to the urine is generally best ascertained by mere inspection; and upon this subject, we have all, and more than is desirable, from Hippocrates himself. Those philosophers, however, who are employed in interrogating disease by chemical analyses, are not often or long in the chambers of the sick. They carry on the investigation of morbid processes in the laboratory of the chemist, and then and there fabricate the appropriate reagents (§ 5½, *a*). He who studies organic nature according to the method of solidism and vitalism, has neither the leisure for those most difficult, unattainable, and laborious analyses, nor would they have any influence upon his judgment as to the pathology or treatment of disease, in the midst of such a multitudinous variety as is presented by the vital phenomena of disease. Of one thing, also, we may rest assured, that nature has supplied all those ready means for interpreting disease that may be necessary for immediate action; nor can we often delay the treatment of acute disease for consultations with the laboratory. In respect to the blood, were it even practicable to learn from analysis its variable conditions in disease, it would reflect no light upon morbid states of the organs, since the qualities of that fluid vary with every varying change in the vital conditions of the solids, and therefore, too, would fail to indicate, in the least, the appropriate remedies. This is also true, in a general sense, of the urine and all other excretions, and secretions. The ready sight, their sensible properties, the vital phenomena, physical signs, experience, and general principles, must be our guide. These may be sometimes facilitated by extraordinary modes of observation, but which are always within the reach and clear understanding of every practitioner; such as the usual mode of examining the blood in inflammatory diseases, evaporating the urine in diabetes, &c. On the contrary, were the humoral doctrines correct, the teaching and the practice of medicine should be restricted to chemists alone; since there is no branch of inquiry so difficult as organic analyses, while their uncertainty would soon prove that the *vis medicatrix naturæ* is the only ordination of nature for the maladies of the human race (§ 691).

428. The *menstrual fluid* is another and a fourth product of excretion; and, from its close resemblance to the blood, in the human species, it is one of the proofs that capillary hemorrhage is generally the result of a secretory process. In the higher orders of animals, even a clearer index of its origin is supplied by the intermixture of blood with the periodic secretion of mucus, which, in lower orders, occurs without blood. The menses, however, is a product *sui generis*, and is

specifically determined by the nature of the part (§ 135). Unlike the other products of excretion, it is not essential as an evacuation, though important to the function of generation. It is therefore peculiar, also, in exerting important vital influences upon the generative system.

429. At certain periods of the year, the female genitals of all animals undergo changes, by which they are developed or prepared for generation; as, for instance, the ovaria of birds become enlarged, the vagina of rabbits and of other animals is tumefied with blood, increased in its vascular action, and pours out an unusual mucous or bloody fluid. It is only at these periods that they are susceptible of impregnation.

430. But woman is capable of impregnation at all times; and that this may happen, her organs must be often developed and prepared for the purpose.

The philosophy of the whole of this preparation, however various in different species, and at whatever intervals of time, is the same in all. The several conditions depend upon changes in the vital states of the generative organs, by which the sexual desire is excited, and the germ rendered susceptible to the stimulus of the semen. This is the end and the aim of the whole.

431. It follows, therefore, that the periodical excretion of the menstrual fluid is only essential to the office of generation, and not to the whole system, excepting so far as this excretion is a healthy function; and the suspension of any function being a morbid condition, the whole system may sympathize with the uterus when the menstrual discharge is suspended.

432. Hence it follows, as a practical result, that all our prescriptions for suspended menstruation must proceed upon the principle that this excretion is a vital, and not a mechanical result; and that its suppression is owing to some morbid state of the uterus, either direct, or sympathetic.

7. CALORIFICATION.

433. Calorification is the function by which plants and animals generate the heat which is peculiar to themselves. Chemistry, however, has enjoyed a more undisturbed exposition of the nature of this function than even that of digestion; nearly all but the most eminent physiologists, such as Hunter and Bichat, having acquiesced in the speculations and assumptions of chemists as setting forth the true philosophy of animal, or, rather, organic heat (§ 333).

It is obvious, therefore, that few things in medical philosophy have greater demands upon the physiologist than a right interpretation of this great and wonderful function of organic life, that its philosophy may be carried to the illustration of other organic processes, that all may be seen as a system of consistent Designs, and that no foot-hold, in the way of analogy, shall remain to him who would substitute artificial devices for the institutions and laws of Nature. The times have, and always have had, a demand upon the physiologist for a critical exposure of this extensive vitiation of medical philosophy. They urge it upon him now more than at former periods. Nothing has been hitherto done but to express opinions; and we now witness, as a consequence, an almost universal substitution of the chemical and phys-

ical theories of life, disease, and therapeutics, for the promptings of the most obvious phenomena of Nature. Mankind, in masses, in the aspect of Nations, are carried away by the simplicity of the chemical dogmas, and by the confidence with which they are uttered. They have become incorporated in most of our works on Physiology, Medicine, Hygiene. Nor is this at all limited to the Medical Profession. It is coextensive with society. It is ingrafted upon popular works; carried into our colleges, academies, and even public schools. It has become a part of the general plan of elementary education; and it is now most extensively an object, through voluminous publications, to induce the whole race of mankind to regulate their food by chemical analysis. Banners, I had almost said, are every where paraded, bearing the inscription from Liebig's Animal Chemistry, that

"**TO DETERMINE WHAT SUBSTANCES ARE CAPABLE OF AFFORDING NOURISHMENT, IT IS ONLY NECESSARY TO ASCERTAIN THE COMPOSITION OF THE FOOD, AND TO COMPARE IT WITH THE INGREDIENTS OF THE BLOOD.**"

434. At the very outset of our inquiry, we discern the speculative nature of the chemical philosophy from the vast difference in the several hypotheses which have been advanced with equal confidence, and which, for awhile, have been received with almost universal favor. The theory of Crawford, which is relative exclusively to the lungs, and to the difference in the capacity for heat of venous and arterial blood, will not soon lose its fascinating simplicity nor the plausibility of its pretensions. Its elegance will stand forever in forcible contrast with that deformity which is the idol of the present day. Genius and taste will never cease to do their mournful homage to one, while they turn from the other as from the distortions of a Pagan deity.

A third hypothesis may be stated as contributing to the improbabilities of the whole, and which has not yet been fully supplanted by the greater novelty. This is that which ascribes the evolution of organic heat to the passage of the common nutritive fluid to a solid state. It has, even more than Crawford's, the merit of philosophical simplicity, and of an apparent foundation in nature, but far less of the spice of genius.

435, *a*. The first two of the foregoing hypotheses have, as one of their indispensable elements, the union of the oxygen of the air with the carbon of the blood, or with that of the body; though, as I have endeavored to show in the Medical and Physiological Commentaries, neither that act in respiration, nor the excretion of carbon, has any greater connection with the production of animal heat than it has with that of the gastric juice, or any other result of organic functions. The whole of that subject is investigated so extensively in the work just mentioned, and, I may say, the speculations and assumptions which have been subsequently put forth by Liebig and his school are, also, so fully considered in the same work, either as already extant, or as likely to ensue, that I shall now limit myself to a statement of the latest and most approved positions of chemistry, and to such remarks and prominent facts as may be necessary to complete the integrity of those fundamental principles which are the main objects of this work, and to show that nature operates in her several departments, respectively, by general and not by partial laws, and that a

stable and perfect foundation may be thus laid, as it exists in nature, for the great superstructure of pathology and therapeutics (§ 2, 892).

435, *b.* The arguments and the facts which I have employed in the foregoing Essay on Animal Heat must have been oftener approved than avowed, since they have been freely adopted by some subsequent writers without indicating the source from whence they were derived (§ 906, *b*).

435, *c.* I may be also permitted to make the following extract from the Preface to the third volume of the Medical and Physiological Commentaries, published four years subsequently to the first two volumes. Thus:

"In respect to chemistry, the author may safely affirm that not a fact has been subsequently disclosed that reflects the smallest light upon physiology or pathology. The whole of that ground, wherever chemistry has obtruded itself upon the science of life and disease, is so amply explained in the former volumes of these Commentaries, that not a substantial fact, nor a vague conclusion, has been put forth by the school of Liebig, which is not there examined, anticipated, and answered, as something which had already an existence, or was likely to emerge from the speculative philosophy of the laboratory then in almost universal vogue" (§ 1 *b*, 350¼, 820 *c*).*

436. What, therefore, I may now say in refutation of this or of other chemical doctrines of organic processes and results, will consist, in part, of a summary view of some of the facts and arguments which are arrayed in copious detail in the Medical and Physiological Commentaries. And, truth being my only object, I shall begin the subject under consideration with a statement of the opinions of some of the most accurate and distinguished observers, which correspond with my own. But to show, however, that nothing but opinions have been expressed even by those who have comprehended the subject, I shall quote from each author all that I have any knowledge of his having said upon the question at issue, with the exception of the little which occurs along with Hunter's observations upon the temperature of trees. I will add, also, in proof of the necessity of these inquiries, that no preceding attempt had been made to show the errors of the chemical doctrines of *digestion*, and that I have incorporated in my prefatory remarks to that investigation all that I could learn from the distinguished authors whom I have there summoned in behalf of philosophy.

437, *a.* Let us, then, hear the great French physiologist. "The extrication of caloric," says Bichat, "is a phenomenon exactly analogous to those of which the general capillary system is the seat."—"The disengagement of caloric is *always subordinate to the state of the vital forces.*"—"The state of respiration has no influence upon the actual heat of the body."—"When we place on one side all the phenomena of animal heat, and on the other the chemical hypothesis, it

* That this opinion is not peculiar to myself appears from critical notices of the *Commentaries.* Thus, for example, it is said by the distinguished author of the "*Climate of the United States and its Endemic Influences,*" that,

"It will be seen that Dr. Paine, in fact, anticipates the whole chemical theory of Liebig, as set forth in his '*Animal Chemistry.*' This he does not only in his *Essay on Vitality*, in which he controverts some of the German professor's opinions, advanced in the '*Organic Chemistry applied to Agriculture and Physiology,*' but likewise in his *Medical and Physiological Commentaries*, published before the appearance of either of Liebig's works."

appears to me so inadequate to the explanation that *I think every methodical mind can refute it without my assistance.*"—BICHAT's *General Anatomy applied to Physiology and Medicine.*

437, *b.* John Hunter, like Bichat, placed the elaboration of organic heat upon the same vital grounds; regarding it as a secreted product. "It is most probable," he says, "that the power of generating heat in animals arises from a principle so connected with life, that it can, and does, act independently of circulation, &c., and is that power which preserves and regulates the internal machine."—HUNTER's *Observations on Certain Parts of the Animal Economy.*

437, *c.* And thus Wilson Philip: "Among the secretions I have ranked the evolution of caloric, although not taking place on any particular surface, because it appeared to be performed by the same power acting on the same fluid; and because, like secreted fluids, it fails when any considerable part of the influence of the brain or spinal cord is withdrawn."—PHILIP's *Experimental Inquiry into the Laws of the Vital Functions* (§ 446, *b*).

437, *d.* And thus the philosophical Moore: "We must allow the bodies of living animals and vegetables to form an original source of heat, as much beyond our power of explaining as the source of the sun's heat."—MOORE's *Medical Sketches.*

437, *e.* And Müller thus: "From the experiments of Dulong and Despretz, it results that, even if the chemical theory of respiration be adopted, *there must be still some other source of animal heat.*" "A general source of animal heat is *undoubtedly* to be found in the *organic processes*, in which, by the *organizing forces* on the organic matter, heat is generated not in one, but in every organ of the body." Again, "Since all organic processes are chiefly dependent on the influence exerted by the nerves on the organic mattter of the body, it cannot appear wonderful if the reciprocal action between the organs and the nerves is a main source of animal heat."—MÜLLER's *Physiology.*

437, *f.* Tiedemann has the same view of the subject. "The only point," he says, "that can be regarded as placed *beyond doubt* is, that the evolution of heat is a *vital act* which depends immediately on the process of nutrition, the conditional and preservative cause of life. The intensity of the evolution of heat, and the property of maintaining itself at a certain temperature proper to each species, are, in animals, in direct ratio with the composition of their organization, and with the sum and intensity of their manifestations of activity."—TIEDEMANN's *Physiology.*

437, *g.* Finally, it is even said by the distinguished chemical physiologist, Dr. Carpenter, that, "It is evident that the chemical doctrine in its present form is insufficient to explain the phenomena of animal calorification."—CARPENTER's *Human Physiology*, p. 611. *London*, 1842.

438, *a.* The very able Dr. Edwards, in his work on the *Influence of Physical Agents on Life*, maintains that "*respiration and animal heat stand related as cause and effect.*" This doctrine is maintained by Edwards with great ability; far more so than by all other authors whom I have consulted. I thought it, therefore, important to dispose of his facts and arguments, in my former work, as far as their plausibility and my own advantage of the right position would admit. There is much said, in the Commentaries, in refutation of that doc-

trine, which is at the foundation of Liebig's (§ 447, *d*), and to which no farther reference will be made in this work.

438, *b*. Coming to the heterogeneous assumptions which distinguish the school of Liebig, there was no difficulty in anticipating the nature of such as might be relative to former theories. I had set forth the various doctrines in their ample dimensions, and brought them to the test of facts and philosophy. The combustion theory was then in vogue, and nearly in the terms as expounded by Liebig. In descanting upon its peculiarities I took for my guide the most recent and approved phraseology, which, it will be seen, is coincident with the supposed novelty; and, although it had numerous and ardent admirers, it passed into such oblivion, in the brief space of two years, that when Liebig promulgated the same hypothesis, and in the same language, it was hailed as one of the most brilliant achievements of that distinguished man (§ 349, *d*). The doctrine which had been thus nearly expressed by Billing, in his "Principles of Medicine," was taken for my text, and is now presented again, in its original typography. Thus:

"We have in the LUNGS a CHARCOAL FIRE constantly burning, and in the OTHER PARTS a WOOD FIRE, the one producing *carbonic acid gas*, the other *carbon; the food supplying*, through the circulation, the vegetable or animal *fuel*, from which the *charcoal* is *prepared* that is *burned* in the *lungs*. It is thus that animal heat is kept up."—BILLING, 1838 (§ 447½ *a*, no. 4).

438, *c*. Somewhat prior to Billing's *day*, Roget had embellished his "Bridgewater Treatise on Animal and Vegetable Physiology," by the following graphic description of the apparatus, and the office which each part fulfills in the generation of animal heat. Thus:

"The food supplies the *fuel*, which is prepared for use by the *digestive organs*, and conveyed *by* the pulmonary arteries to *the place* where it is to undergo *combustion*. The *diaphragm* is the *bellows* which feeds the *furnace* with *air;* and the *trachea* is the *chimney* through which the carbonic acid, which is the product of combustion, escapes."—ROGET (§ 350¾, *f*).

438, *d*. Now, the only fundamental difference between the foregoing and Liebig's hypothesis is this: The former supposes the combustion to take place in the lungs, the latter in every other part *excepting the lungs*, where, as will be seen, a special provision is made for the temperature of those organs (§ 447½, *f*).

That no imaginary obstacle may lie in the way of the vital theory, and that truth may have the advantage of rival doctrines by their close apposition, and that knowledge may not be limited to the facts and deductions of unadulterated science, it remains to show, by a series of quotations from Liebig's Animal Chemistry, that the doctrine of the dependence of organic heat upon the chemical process of combustion has gained nothing from the Laboratory at Geissen; while the attentive reader will find in the extracts themselves the most ample proof of its untenable nature. This, indeed, may have been well anticipated from what I have shown of this philosopher's regard for facts and consistency in section 350. Indeed, the same incongruities, the same contradictions, and worse assumptions, go to form the whole fabric of Liebig's disquisitions upon animal heat, as I have shown to make up his jumble respecting digestion, and other great functions, as well as properties of living beings.

I shall endeavor to execute my task with the same efficiency as was attempted in relation to the chemical views of digestion (§ 350), in the earnest hope that the chemist may discern the error of his ways, and leave to the student of Organic Nature those difficult problems which concern the highest welfare of man, and whose consistency, in their philosophical bearing, cannot be disturbed without laying in ruins every principle in physiology, and carrying death into the chambers of the sick (§ 4 *a*, 5, 5½ *a*, 376½, 376¾ *b*, 819, &c.).

440, *a*. Let us begin, then, with a statement of the doctrine as summarily delivered by Liebig in his work on *Animal Chemistry*, and we shall see from the first proposition that it is essentially the old speculation (§ 438, *b*), alike based upon artificial expedients, and upon the assumption that the living organism is a mere chemical apparatus, destitute of all properties and laws that are not common to dead matter.

1. "It is evident that the supply of heat lost by cooling is effected by the mutual action of the elements of the food and the inspired oxygen, which combine together. The animal body acts, in this respect, *as a furnace which we supply with fuel.*" "In order to keep up in the furnace a constant temperature, *we must vary the supply of fuel according to the external temperature, that is, according to the supply of oxygen.*"—*Animal Chemistry.*

It will be seen, from the close of the foregoing quotation, that a capital error is made in assuming a law that the quantity of food is regulated by the temperature of the air (§ 440 *c*, *no.* 12). That assumption is carried out in opposition to all well-known facts; while it is also assumed as a law, that animal heat, whatever its uniformity in the warm-blooded animal, or its instability in the cold-blooded, depends upon the relative law of the temperature of the air and the quantity of food consumed, although this law is virtually contradicted by various other requisites for the promotion and maintenance of animal heat. But let us have another unqualified proposition which defines the law in relation to the dependence of animal heat upon external temperature and the food consumed. Thus:

2. "In different climates, the quantity of oxygen introduced into the system by respiration varies according to the temperature of the external air. The quantity of inspired oxygen increases with the loss of heat by external cooling, and the quantity of carbon or hydrogen necessary to combine with this oxygen must be increased in the same ratio."—*Animal Chemistry.*

Now compare the following, 3, 4, and 5, with the preceding 1 and 2, and observe the conflict between them, and the contingencies upon which the great law is made to depend, that determines a uniform temperature. Thus:

3. "The *quantity of oxygen* consumed varies according to the temperature and density of the air, according to the degree of motion, labor, or exercise, to the amount and quality of the food, to the comparative warmth of the clothing, and also according to the time within which the food is taken"! A proposition mostly relative to man, and unfounded as to him (§ 440, *c*).

4. "*The quantity of food* is regulated by the number of respirations, by the temperature of the air, and by the amount of heat given off to the surrounding medium"! (§ 447, *c*).

5. "*The mutual action between the elements of the food and the oxygen conveyed by the circulation of the blood to every part of the body* IS THE SOURCE OF ANIMAL HEAT." "*For a given amount of oxygen the heat produced is, in all cases, exactly the same.*"—LIEBIG'S *Animal Chemistry* (§ 447, *c*).

6. "There is not the smallest support to the opinion that there exists, in the animal body, any other unknown source of heat, besides the mutual *chemical action* between the elements of the food and the oxygen of the air."—*Animal Chemistry.*

No farther comment is necessary to indicate the complexities and contradictions involved in the foregoing quotations; such as "the quantity of oxygen consumed depends on the amount and quality of the food," while "the *quantity of food* is regulated by the number of respirations," that is, by "the quantity of oxygen consumed," &c.

If, also, we now add to the foregoing, 1, 2, 3, 4, 5, 6, other contingencies upon which it is assumed that animal heat depends, we shall have such a variety of accidental circumstances to interpret the uniform temperature of *each individual* of every species of animal, and that, too, according to the constitutional peculiarities of each species, that the nature of the chemical rationale will be sufficiently obvious. Thus:

7. "Where the food contains meat, fat, and *wine*, by reason of the hydrogen in those kinds of food which is oxydized, and which, in being converted into water, it evolves much more heat for equal weights."

8. "The cooling of the body, by *whatever cause* it may be produced, increases the amount of food necessary. The mere exposure to the cold air, &c., increases the loss of heat, and *compels* us to eat more than usual. [!] The same is true of those who are accustomed to drink large quantities of cold water. It increases the appetite, [!] and persons of a weak constitution find it necessary, by continued exercise, to supply to the system the oxygen required to restore the heat abstracted by the cold water"!—*Animal Chemistry.*

440, *b.* Here I pause for a moment, to advert to the ground of the assumptions in the quotations 7 and 8. The reason is one which goes conclusively to the vital theory of animal heat. When wine, for example, is taken into the stomach, an evolution of heat ensues as soon as the stimulant is swallowed, in virtue of its stimulant effect on that organ. In the same way meat stimulates more than vegetables, and will light up a glow upon a cold surface before its digestion has begun (§ 512, *b*). In respect to the superiority of cold water in provoking hunger, there is no other way of explaining the philosophy against the fact than by supposing "the Reformer" was pledged to the popular cause of temperance. But since wine, brandy, &c., far more than cold water, "increase the appetite" and "compel us to eat more than usual," and since these fluids are said to yield a far greater amount of "fuel" to the system than the food itself (whose main object is also supposed to supply the means of combustion), it should follow, upon our author's premises, that less food would be necessary to the purposes of life, in proportion to the quantity of alcohol consumed, and therefore that wine should, in reality, diminish the appetite and "compel us to eat less than usual" (nos. 4, 7; § 441, *e*).

It may be worth observing, also, in respect to the "cold water," that the assumption is founded upon several important mistakes;

namely, 1st. That the appetite is virtually regulated by the condition of the calorific process; 2d. That "the animal body bears the same relation to surrounding objects (in respect to an interchange of caloric), as any other heated mass" (no. 14); and, 3d. That drinking cold water diminishes the temperature of the body (§ 442, *b*, *c*, *d*, *e*). And the most strenuous and extensive efforts have been made to choke down these absurdities under the penalty of being lampooned as an enemy to "experimental philosophy" (§ 5½, *a*). I have no doubt, however, that they will forcibly remind the reader of the parallel quotations, and of the pathological and therapeutical principles which emanate from them in the two subsequent sections.

440, *bb*. As to the "fat" (no. 7), the chemist assumed that to be an important source of animal heat, because it is one of the best substances for combustion "in the air or in oxygen gas" (no. 10); and this hypothesis conducts him to the ludicrous mistake of regarding it equally, and in the same aspect, as a source of animal heat, whether it be taken as an article of food and converted into chyme, or consist of food which has been converted into the fat that makes up a part of the consumer. The uniform temperature, therefore, among a variety of other things, will depend not only on the amount of fat eaten, but on the amount formed out of the blood. This leads our author to say that,

9. "If we were to go naked, like certain savage tribes, or if in hunting or fishing we were exposed to the same degree of cold as the Samoyedes, we should be able with ease to consume ten pounds of flesh, [!] and perhaps a dozen of tallow candles into the bargain, daily, as warmly-clad travelers have related with astonishment of these people. [!] We should then, also, be able to take *the same quantity of brandy* or train oil *without bad effects*, because the carbon and hydrogen of these substances would only suffice to keep up the equilibrium between the external temperature and that of our bodies."—*Animal Chemistry*.

And that, too, in a critical work on science which professes a rigorous adherence to facts, as the only apology for a contemptuous derision of long-established doctrines, and as the only basis for the attempted substitutes. But let us now turn from "fat" as a combustible substance, *via* the digestive apparatus, to "fat" as appertaining to the organized tissues.

10. "The formation of *fat* depends on a deficiency of oxygen. But, in this process, in the formation of fat itself, there is opened up *a new source of animal heat*. The oxygen set free in the formation of fat is given out in combination with carbon or hydrogen, and there must have been generated by the formation of carbonic acid or water as much heat as if an equal weight of carbon or hydrogen had been burned in air or in oxygen gas."—LIEBIG'S *Organic Chemistry*, &c.

Introductory to the foregoing quotation, we are told, that,

"The production of fat is always a consequence of a deficient supply of oxygen, for oxygen is absolutely indispensable for the dissipation of excess of carbon in the food."

And then we are referred, in illustration, to the "lean, muscular, sinewy limbs that are exhibited with pride by the Bedouin and Arab of the desert" (*c*). But what says the variety in respect to fat, and oxygen, and heat, that prevails among the tenants of the ocean, who have but one

common supply of food? Contrast, for example, the blubber of the whale, who breathes with lungs, with many a lean, voracious, cold-blooded animal that respires with gills. The hypothesis, therefore, falls (no. $11\frac{1}{2}$, and § 443, *b*). Or, if it survive such difficulties, take, then, the following statement, designed as an important basis for the combustion theory, and which should have had a place among our author's pathological doctrines (§ $350\frac{1}{2}$). But our present interest lies in the fact that it appears, after all, that it is not "true without exception," that "the production of fat is always in consequence of a deficient supply of oxygen." Thus:

"Exercise and labor cause a diminution in the quantity of the menstrual discharge; and when it is suppressed in consequence of disease, the vegetative life is manifested in a *morbid production of fat*"!

Here is another "most trustworthy observation," and "perfectly conclusive" as to our author's doctrine. Thus:

"The quantities of oxygen which a whale and a carrier's horse can inspire in a given time are very unequal. The temperature, as well as the quantity of oxygen, is much greater in the horse."—LIEBIG's *Animal Chemistry*, &c.

Now the temperature of the whale in the frozen seas is more than 100° Fh., nor can the "carrier" bring up that of his horse to a higher degree, with the aid of a tropical sun. It is evident that our author has regarded the whale as a cold-blooded fish.

440, *c*. I shall not now stop to inquire farther into the factitious nature of the foregoing doctrine, but go on with other extracts in which the author endeavors to sustain his great law of animal heat (5, 6), and expound by other contingencies that exact temperature which distinguishes every warm-blooded individual of every species of animal, and according to the nature of the species, and with scarce a variation, at all seasons, in all climates, at all ages, with all kinds and quantities of food, from him who "devours 10 lbs. of flesh and a dozen tallow candles into the bargain, daily, and the same quantity of brandy and train oil without bad effects" (no. 9), to him who, like "old Cornaro," lives on "half an egg a day;" and whether clad in the flannels and woolen broadcloths that are preferred as matters of comfort by many inhabitants of tropical climates, or absolutely naked, with Fahrenheit at 40° and lower, like the Petcherai Indians (442, *b*); or, whether sleeping or waking, sitting or standing, running or walking, in an ice-house or in an oven, in all past time, now, and forever; whatever statements our "Reformer" may make to the contrary notwithstanding. It will appear, therefore, that the following affirmations should be carefully considered, before they are admitted as appendages to the general law; namely,

11. "Our clothing is merely an equivalent for a certain amount of food. [!] The more warmly we are clothed the less urgent becomes the appetite for food, [!] because the loss of heat by cooling, and consequently the amount of heat to be supplied by the food, is diminished" (no. 9, and 12, and § 442 *a*, *c*).

Here our author predicates two important errors of the hypothesis which they are intended to sustain; the assumptions and the hypothesis being mutually designed to support each other.

$11\frac{1}{2}$. But again; having seen that (in the language of Mr. Ancell, "the Reformer's" interpreter) "the *deposition* of fat is supposed to

act as a *substitute for free respiration* in the production of heat" (no. 10), we shall not be surprised to learn that "its *absorption* answers as a *substitute for food* in the production of animal heat." So it is extensively affirmed in the work on *Animal Chemistry*.

Why, then, is the temperature of a very fat ox and a very lean one, or of a very fat man and a very lean one, exactly the same in each species, respectively? Why does the fat man sustain a much less exaltation of heat than the lean one, when emaciation is in rapid progress in febrile diseases? Why those daily periodical evolutions of heat (100° to 110° Fh.), in the emaciated subject of phthisis, subsisting on barley-water; and respiring with lungs unfitted for half their usual functions? And this leads me to state the chemical philosophy of mania and delirium, which flows immediately from the subject before us; and by which we learn, also, what is more important, the extent of our author's theory of combustion. Thus:

"In the progress of starvation it is not only the fat which disappears, but also, by degrees, all such of the solids as are capable of being dissolved. In the wasted body of those who have suffered starvation, the muscles are shrunk and unnaturally soft, and have lost their contractility. All those parts of the body which were capable of entering into a state of motion, have served to protect the remainder of the frame from the destructive influence of the atmosphere. [!] Toward the end, the particles of the brain begin to undergo the process of oxydation, and *delirium*, *mania*, and death, close the scene."

This construction of the cause of delirium and mania is conformable to the author's hypothesis of thought, mental emotions, &c. (§ 349, *e*); but that the phenomena are due to totally different influences "in the progress of starvation," is shown by the uniform preservation of the intellectual powers in the most emaciated subjects of phthisis pulmonalis (§ 441, *c*).

440, *cc*. But, we are only beginning with the contingencies which contribute to the fundamental principle of animal heat, and which are designed to interpret its remarkable uniformity, yet variety, in different species of the warm-blooded tribes, and its variableness in the cold-blooded, and to bring the general doctrine into correspondence with a great law of caloric which prevails in the inorganic world (§ 440 *e*, no. 14).

12. "In cold and temperate climates, the air which incessantly strives to consume the body [!] urges man to laborious efforts in order to furnish the means of resistance to its action, while, in hot climates, the necessity of labor to provide food is far less urgent" (§ 445, *b*).—*Animal Chemistry*.

In the first place, all animals are overlooked in the foregoing statement, and our philosopher is actually regarding man as the only living creature who has a temperature above the surrounding atmosphere; for it surely will not be said of animals that they must work harder for a supply of food in temperate than in warmer climates. Nor will the reader fail to observe that much of the statements and reasoning, throughout, is predicated specifically of man, and of man, too, in a state of health.

As to the necessity of more "laborious efforts to provide food" in cold than in hot climates, a very different philosophy lies at its bottom than assigned by Liebig, which consists in the greater necessity of

labor to cultivate the earth and raise the means of supply in the former than the latter sections of the globe. It is evident, also, that "the Reformer" had not only man exclusively in view, but in that part of the contrast which relates to "hot climates," he was thinking alone of the indolent and luxurious master, without reference to the slave, who toils the day long under a torrid sun for his own scanty subsistence and his master's too.

But again, although man be compelled to work in cold climates "to provide food" to keep up his temperature, while this "necessity for labor is far less urgent in hot climates," the cold-blooded finny tribe, and the warm-blooded whale, and beasts of prey are quite on an equality, in that respect, in all regions of the earth.

440, *d*. But, we are yet far from the end of the "contingent influences" which modify the exact law of animal heat (nos. 5, 6), and which go to the preservation of its exact uniformity. One of our author's hypotheses, which will be soon stated (no. 14), betrays him into a mistake, which has been often made and as often exposed. Thus:

13. "*The contraction of muscles produces heat;* but the force necessary for the contraction has manifested itself through the organs of motion, in which it has been excited by chemical changes. The ultimate cause of the heat produced is, therefore, to be found in these chemical changes."—*Animal Chemistry.*

Now, setting aside the sophistry of this reasoning in a circle, we have the simple proposition that "*the contraction of muscles produces heat;*" and evidently because "a piece of caoutchouc, when rapidly drawn out, forcibly contracts again, with disengagement of heat." And to this conclusion the "Reformer" was impelled by his fundamental doctrine that the living and the dead are undistinguishably governed by the same properties and laws, as implied by no. 14, and as extensively set forth in § 350. This assumption as to the effects of muscular motion I have sufficiently noticed in my former Essay on Animal Heat; but it may be now said that it is disproved by the uniformity of animal heat in all warm-blooded vertebrata, under all circumstances of rest and exercise. When the latter is sufficient to give an impulse to the general circulatory and other organs, an increased evolution of animal heat is liable to happen, like an increased flow of saliva, sweat, or any other secreted product; but it does not happen with any certainty, and is never due to the physical causes assigned; neither the mechanical one of "muscular contraction," nor the "chemical changes."

440, *e*. I come now to one of our philosopher's parallelisms of organic and inorganic beings in respect to their great laws and functions, and which necessarily flows from the grand physical hypothesis that the living body is a mere chemical apparatus. Thus:

14. "The animal body is a heated mass, which bears THE SAME RELATION TO SURROUNDING OBJECTS AS ANY OTHER HEATED MASS. It receives heat when the surrounding objects are hotter, it loses heat when they are colder than itself."—*Animal Chemistry.* (See § 350$\frac{2}{3}$, *e*.)

Thus we have throughout a consecutive series of mistakes and blunders, emanating from a false position in respect to the fundamental constitution of living beings; while this perversion of nature is the monomania of materialism. But there remains much of the like nature yet in prospect.

From the last proposition, and from the common level in which living and dead objects are regarded, and in his unacquaintance with physiological facts, the chemist has been betrayed into the supposition that all the contingent circumstances which I have now stated (nos. 1–14) contribute, along with the fundamental law, 5 and 6, to the production and maintenance of that uniform temperature by which every warm-blooded vertebrata is distinguished, while every other product of the tissues is forever variable in quantity, and which are to explain equally, also, the vicissitudes of the cold-blooded race, and all the diversities of temperature which spring from disease.

The plainest facts in "experimental philosophy" contradict the assumption, and place the generation of animal heat upon its own independent ground. If we enter an apartment heated to 260° F., the temperature of the body remains unaffected; and equally so in a bath of water, where all evaporation is prevented. If we pass the day in an ice-house, or dwell in an atmosphere at 50° below the zero of Fahrenheit, it is all the same (§ 442, *c*, *d*). If water, at zero, be dashed on the body, a glowing heat is instantly lighted up on the surface; and so it is upon the cold and shriveled skin of the starving man as soon as food shall have entered his stomach. A flash of indignation, or an impulse of shame, will, on the instant, set the whole face in a state of "combustion;" the face being then said, by common consent, to "burn" (§ 441, *c*).

With the last proposition (14) goes another which has the concurrence of all; namely,

15. "The heat given off to the surrounding medium is restored within the body with great rapidity."—"All living creatures, whose existence depends on the absorption of oxygen, possess within themselves a source of heat independent of surrounding objects."

16. And (for the third time, 5 and 6), "This disengagement of heat is, uniformly and under all circumstances, the result of the combination of a combustible substance with oxygen."—*Animal Chemistry.*

Such a chemical machine, with an internal source of heat, and constantly liable to elevations and depressions of temperature from "surrounding objects like any other heated mass," could possess no stability of temperature,—none comparable with the inanimate objects by which its own internal source of heat is said to be influenced; and when we superadd the various other contingencies, the varying quantities and qualities of food, variableness of respiration, the oxygen respired, clothing, climate, season, weather, rest or exercise, age, fat, candles, train oil, and rum, which are said to have important influences on animal heat (nos. 1–14), and then carry out the assumed relation of the living body to "surrounding objects," and thus identify it with a "heated mass" of iron, a thousand other modifying contingencies present themselves, which, in connection with the "internal independent source of heat," should render the temperature of the living warm-blooded vertebrata variable at every moment, while that of the cold-blooded animal should be distinguished by the greater uniformity.

It need scarcely be added, that the warm-blooded vertebrata are remarkably exempt from the law which chemistry, to be consistent, imputes to them as conductors of caloric (no. 14). And herein, as

every where else, chemistry betrays the fallacy of its fundamental assumption (nos. 5, 6, 16). The warm-blooded vertebrata are especially contradistinguished from "*other heated masses*, in their relation to surrounding objects," by their resistance of heat from external objects (§ 441 *c*, 442 *e*); and this contradistinction is not only shown by universal experience, but forcibly so by the comparative relation which cold-blooded animals and "other heated masses bear to surrounding objects." These animals depend mostly for their temperature upon that of the surrounding medium, and consequently sustain much of the relation of "other heated masses." Still, they possess not only a feeble power of generating heat, but, what is more to my purpose, they have a corresponding power of resisting its ingress from surrounding objects, since it was ascertained by Crawford that "*a living frog acquires heat more slowly than a dead one*."—*London Philosoph. Trans.*, 1781, p. 485.

It is also worthy of remark, that the chemist has mistaken the rise of animal heat, when occasioned by the heat of a fire, for that interchange of caloric which takes place between inanimate substances of different temperatures. The phenomenon is peculiarly a fact for the vitalist, since, in the former case, the rise of heat is due to the action of caloric as a stimulant to the organic functions (§ 188½).

On the other hand, when the temperature falls from the direct action of cold upon the living body, it is from the abduction of heat from the superficial capillaries alone, by which the calorific function is arrested not only in the skin, but may be also, sympathetically, throughout the body. And what also forcibly shows the vital nature of this phenomenon, is the frequent and speedy exaltation of the cutaneous heat after its sudden reduction by the application of cold water.

440, *f*. In the midst of so much error and confusion, it is no difficult matter, as already seen (§ 350), to paralyze an author by an exposure of palpable contradictions in fundamental doctrines. As an example of this nature in relation to the present subject, I shall place in opposition the following statements:

Affirmative.

17. "In whatever way carbon may combine with oxygen, the act of combination cannot take place without the disengagement of heat. *It is a matter of indifference whether the combination* take place at a HIGH OR AT A LOW TEMPERATURE; the amount of heat liberated is a constant quantity."

"In the foregoing pages, it has been assumed that it is especially CARBON and hydrogen which, *by combining with oxygen*, serve to produce animal heat."

"The carbon of the food, which is converted into carbonic acid within the body, must give out exactly as much heat as if it had

Negative.

18. "Carbon never combines at common temperatures with oxygen, so as to form carbonic acid."

"There is NO EXAMPLE of *carbon combining directly with oxygen at common temperatures;* but numerous facts show that *hydrogen*, in certain states of condensation, possesses that property. *Lamp-black which has been heated to redness* may be *kept in contact with oxygen gas, without forming carbonic acid.* The spontaneous inflammability of the charcoal used in the fabrication of gunpowder has been correctly ascribed to the hydrogen which it contains in considerable quantity; for during its

been directly burned in the air or in oxygen gas."

"The 13·9 oz. of carbon which are daily converted into carbonic acid in the body of an adult, evolve 197477 degrees of heat, which is sufficient to raise the temperature of 370 lbs. of water to 98·3°, the temperature of the human body." — LIEBIG'S *Animal Chemistry*, 1842. [See, also, nos. 5, 6, 16.]

reduction to powder, no trace of carbonic acid can be detected in the air surrounding it. It is not formed until *the temperature of the mass has reached the red heat.* The heat which produces the inflammation is therefore *not caused by the oxydation of the carbon.*"— LIEBIG'S *Organic Chemistry applied to Physiology*, &c., p. 263, 311.

440, *g*. These contradictory doctrines were put forth in different works, but almost simultaneously, and each was designed to sustain important hypotheses that regarded, respectively, the negative and the affirmative statement. But, even in the work on *Animal Chemistry*, a subject collateral to the general hypothesis of animal heat leads the author to a partial contradiction of his all-pervading idea of the ready combustion of carbon at temperatures as low, at least, as those of cold-blooded animals; since, upon that collateral subject, he says, "*at the temperature of the* (warm-blooded) *body*, the affinity of hydrogen for oxygen *far surpasses* that of carbon for the same element." (See § 441, *e*.)

440, *h*. I shall not undertake to decide whether oxygen unites singly with carbon or hydrogen, in the living body, or along with other elements from which the carbon is ultimately excreted, nor is it the province of these Institutes to inquire into a truth which belongs to the laboratory. In my former Essay on Animal Heat, I have examined this subject in its physiological aspect adversely to the chemical doctrine, and in conformity with the great law which excludes the formation of all inorganic compounds within the living organism, as set forth by chemistry (§ 38, 39, 419).

440, *i*. Of the remaining subsidiary causes, that relative to the bile should not be neglected. It is thus summarily expressed by Liebig's interpreter, Mr. Ancell:

19. "These facts, and the reasoning founded upon them, have led Liebig to the conclusion that the FUNCTION OF THE BILE is to support respiration and produce animal heat, by presenting carbon and hydrogen in a very soluble form to the oxygen of arterial blood."—MR. ANCELL, *in London Lancet*, 1843.

The reader will, therefore, the more readily comprehend the doctrine of "the Reformer" as stated in the following language. Thus:

"In the *carnivora* the bile contains the carbon of the metamorphosed tissues. This carbon disappears in the animal body, and the bile likewise disappears in the vital process. Its carbon and hydrogen are given out through the skin and lungs as carbonic acid and water; and hence it is obvious that the elements of the bile serve for respiration and for the production of animal heat."—*Animal Chemistry*.

That may answer for the "*carnivora*;" while the graminivora depend more upon their "fat," and other tribes upon their special allotments.

Having already adverted to the true uses of the bile (§ 314–316,

409 *f*), I shall proceed to say, without stopping to inquire how the foregoing "facts" were ascertained, that this part of the doctrine will hardly abide the test of morbid conditions. It often happens, for instance, when the production of bile is nearly or wholly arrested, that the temperature of the body is exalted above its natural standard, while at other times, when the bile is redundant, the temperature sinks below its equilibrium. This, too, is familiar to physicians as occurring in the progress of the same disease; and I have thus introduced this subject more for its bearing upon physiology and disease, than on account of its perversion by the chemist.

441, *a*. Having now set forth the principal doctrine, and the most important contingencies which are brought to its support, I shall proceed to make some farther comments both upon the doctrine and its auxiliaries, and present a variety of facts in confirmation of the physiological theory of animal heat.

441, *b*. In the first place, it is worthy of farther remark in regard to a principal element of the main hypothesis, that scarcely any two individuals, of whatever species, consume the same quantities of food in a given time, while society abounds with habitual examples, where, under the same circumstances of age, health, sex, climate, temperature, employment, &c., there is every gradation in quantity from a daily consumption of many pounds to a few ounces, or with slight variations as to quantity in many individuals. Without, however, now reverting to the preceding relative statements of our author, let us adduce another for the sake of its logic and precision. Thus:

"The consumption of oxygen in equal times may be expressed by the number of respirations. It is clear that in the same individual the quantity of nourishment required must vary with the force and number of the respirations."—*Animal Chemistry.*

Immediately after this quotation, which has for its object an adjustment of "the quantity of nourishment required" for the assumed amount of carbonic acid generated in the body, we are told that,

"A child, in whom the organs of respiration are naturally very active, requires food oftener than an adult."

Thus, therefore, according to this statement (which has the merit of being true, not only as it respects a "child," but all young animals), the author has presented a fact subversive of his hypothesis relative to the source of animal heat; since, if a "child" and all young animals consume more food and oxygen in the ratio of their size than men and adult animals, the power of evolving heat should be greater in the young than in the adult. But the experiments of Edwards, and others, have demonstrated that young warm-blooded animals may be cooled down rapidly to near the temperature of the surrounding air, which is impracticable with adults. But Edwards adds the fact, which farther confirms the vital doctrine of the generation of animal heat, that "*the rapid progress which they make in acquiring the power of producing heat is wonderful.*" The same facts are applicable to a "child," though probably less so than to unfledged birds, puppies, &c. (§ 153–155, 442 *a*, 445 *f*). I may finally add, that the whole of this subject is extensively considered in my former Essay on Animal Heat.

441, *c*. Nor can I neglect referring the reader to the facts which I have arrayed in the Commentaries upon the subject of food, with a view as well to the humoral pathology as to the chemical doctrine of

animal heat,—how the northern savages, as known by observation, and from the necessity of the case, consume much less food than the civilized man of the temperate and even equatorial climates; the former, also, often breaking his fast only at distant intervals. There,* too, may be found a multitude of corresponding facts in relation to the endurance of *Fasting* without any sensible influence on the human system,—a general survey, also, of the habits of animals in relation to temperature, and which, like many of my arguments and other facts, have been advantageously employed by subsequent writers to accomplish what I had already done. I have urged the fact, in respect to animals, that they enjoy, *ex necessitate rei*, but a scanty supply of food in the arctic regions, and that, when gorged with the same sustenance on their removal to warmer climates, they still maintain nearly their original constitutional temperature; and there may be found a series of facts as to the relative temperature of the warm-blooded and the cold-blooded tenants of the deep, which, side by side in the arctic seas, subsist on food of the same quality; the whale, with a temperature of 102° F., and the far more voracious shark, whose heat is down to a lower standard. There it is urged, that when the emaciated hibernating animal is roused by pricking, &c., ay, even by exposure to a still lower temperature, 25° F., his heat suddenly rises from 39° to 97° F.; besides a multitude of similar proofs which should be examined in connection with what I have said extensively on the influence of the *nervous system* upon the generation of organic heat in the warm-blooded vertebrata.

How poorly accords our author's assumption as to the greater voracity of polar animals with the well-known facts relative to the hyenas, tigers, lions, crocodiles, vultures, *cormorants*, &c., that range in temperate and equatorial quarters! And what answer will chemistry make to the poor ability of all tropical animals to bear even the autumnal cold of the temperate zones, whatever the quantity of food?

But the facts are "the things," and let us, therefore, have them (§ $5\frac{1}{4}$, *a*). They will show how far "the animal body bears the same relation to surrounding objects as any other heated *mass*" (§ 440 *e*, no. 14), and how far a large supply of food is necessary to the same animal temperature in frozen regions as appertains to the inhabitants of warmer climates.

In the *Commentaries*, then, I have called to witness, against the assumptions which I am again employed in refuting, the half-starved bears, and foxes, and reindeers, and hares, and even small birds, subsisting on a scanty amount of half-frozen food, and respiring and surrounded by an atmosphere at 30° to 50° below the zero of Fahrenheit; yet maintaining about the same temperature as when transported to a southern climate. I have said that "in 15 out of 16 foxes, the temperature was 100° to $106\frac{3}{4}$°, in the other 98°; the thermometer ranging below zero from 3° to 32° Fh. Capt. Lyon found that the *tetro albus* maintained its temperature at 50° below zero. It was, also, equally so with the smallest birds" (§ 442 *b*, 842 *d*).

After what has been stated, however, of "tallow candles," "laborious efforts," "heated masses," "clothing," &c. (§ 440, nos. 9, 11, 12), the reader will not be surprised at our author's statement that, "*every*

* Medical and Physiological Commentaries, vol. i., p. 691–695. Also, the Essay on Animal Heat, in vol. ii.

one knows that the animals of prey in the arctic regions far exceed in voracity those of the torrid zone." And yet "every one knows" that the consumption of food is universally greatest where it is most abundant, and therefore least where it is assumed to be most abundant.

And what will the disciples of chemistry say to the fact that the low-born of the North of Europe, the exiles of Siberia, &c., often get little more than bread made from the wood of trees, and a wardrobe equally expressive of their destitution of the "comforts of life" (§ 442 *e*, and *Commentaries*, vol. i., p. 691–698)? What is the contrast in temperature between the well-fed loungers of Europe and the half-starved laborers of the same countries? What, again, between the slave and his master? One, too, feasting on animal food and other highly "combustible matter," in the shape of brandy, porter, wine, &c., while the other gets nothing but potatoes, yams, or bread, at best, and limpid water (nos. 7, 8)? Their temperature is alike. The only contrast in the case is between truth and error. Is the balance, then, to be found in the difference of clothing (no. 11)? Exactly otherwise; for the man of ease is incased with flannels and broadcloths, and lives in heated apartments (no. 10), while he of the shovel or the hod is no less contented and comfortable in rags, and whether he repose upon a bed of straw or a bank of snow. And here I may add, what is equally fatal to the chemical hypothesis, that this houseless *sans culottes* will maintain his warmth better with water than with rum, and that, the more he consumes of the "combustible substance," the greater will be his danger from frost (nos. 7, 9).

It is also manifest that the ever-varying quantities and qualities of food employed by man, in temperate and torrid zones, while his heat is always nearly the same, shows, with my other facts, that it is less dependent on food than are other products of organization. More especially is this demonstrated in many acute diseases, where the temperature of the body, or of particular parts only, is often greatly exalted, and where, too, the patient is wholly deprived of food, and emaciation so far advanced that not only the "fat," but the very "tissues" are nearly "consumed."

Without inquiring into the hypothesis that meat is more combustible, and yields a greater quantity of heat than vegetable matter, it is important to place their relations to the calorific function in the proper physiological aspect.

There is no doubt that the generation of heat is more promoted by animal than by vegetable food, until the system is accommodated to the latter by its habitual use; and even then the preponderance will be in favor of the former in high northern latitudes. The principle to which I now advert depends upon the law of vital habit and that which relates to the virtues of different natural stimuli, and is as foreign from chemistry as any two subjects can be from each other (§ 136, 150–152, 188½, 442, 512 *b*, 535–568).

The whole philosophy, then, which concerns the greater tendency of animal than of vegetable food to promote the generation of heat, consists in the fact that animal is a greater stimulus than vegetable matter to the organic functions (§ 188½, 512 *b*). The fact is demonstrable, as I have said, while the food lies yet undigested upon the stomach of the famished wayfarer; and every one knows that his warmth will be thus instantly increased to a greater degree by cold

meat than by cold potatoes (§ 512, *b*). And so is it, to a greater extent, with the alcoholic liquors which the chemist assumes are burned in the recesses of the organization (nos. 7, 9). The principle which concerns the whole is exactly the same as when warm water lights up a glow upon the surface, or determines perspiration, or an act of vomiting. Here, too, in all this development of heat, as in the other results, is involved a magnificent agency of the nervous power, but which to the chemist is impenetrable darkness (§ 350, no. 97, 500 *n*, 512 *b*).

Those that have but imperfect views in physiology may comprehend the merits of this subject by considering the relative effects of animal and vegetable food in fevers and inflammations. An ounce of the mildest broth may raise the temperature many degrees, while a liberal supply of appropriate vegetable food would have no such influence; though a great exaltation of temperature would ensue upon solid vegetable food that should not undergo digestion. The reason of all this gives the right interpretation to the relative effects of animal and vegetable food in the generation of heat in ordinary states of the system, or till habit may interpose its influence. Irritability being in an exalted state in febrile affections, is more than usually susceptible of the stimulus of animal food, and hence the increase of vascular action and the greater evolution of heat (§ 137 *d*, 150, 188, &c., 441½ *b*, 535, &c.).

Where vegetable food remains undigested, in the foregoing case, it becomes a morbid irritant to the stomach, and the cause of sympathetic influences that augment the fever or the inflammation, and thus engenders a rise of temperature (§ 137 *d*, 150–152, 222, &c., 512, &c.).

The same philosophy is applicable to differences in climate. Little vegetable food is consumed in the arctic regions, and, as little animal food should be eaten by man in the equatorial. Nature has ordained this allotment to men and animals, by a scanty vegetation at the north, while she appears to have limited her provision of animal food in tropical climates to the wants of the carnivorous race. To the north she has given beasts and birds, but with a stinted hand, and has been scarcely more liberal of the tenants of the deep. To the tropics a profusion of esculent roots, fruits, &c.; and has displayed a munificence in animal and vegetable creation throughout the vast temperate regions. This ordination of nature is particularly suited to the exigencies of the human constitution. Animal food is especially stimulating to all the functions of man, and therefore to that which generates heat. Irritability is greater, more susceptible to the action of stimuli, in equatorial than in other climates. The tropical heat is its measure of endurance; and when the stimulus of animal food is superadded, the tropical man is extremely prone to fever, and dies early. If wine, brandy, &c., be added also, so much the worse; but not because it is "burned" in the body (§ 188, &c., 615, &c., 618). Our author's philosophy, however, is too much of a curiosity to be neglected, and should have gone along with the pathological inductions (§ 350½). Thus:

"The Englishman in Jamaica sees with regret the disappearance of his appetite, previously a source of frequently-recurring enjoyment; and he succeeds, by the use of Cayenne pepper and the most powerful stimulants, in enabling himself to take as much food as he

was accustomed to eat at home. But the whole of the carbon thus introduced into the system is not consumed. The temperature of the air is too high, and the oppressive heat does not allow him to increase the number of respirations by active exercise, and thus to proportion the waste to the amount of food taken. *Disease of some kind*, THEREFORE, *ensues*."—*Animal Chemistry*.

Again, also, for a like physiological reason that animal food is too stimulating for man in tropical climates, vegetable is not sufficiently so for the obtuse irritability of the northern man (§ 191, 585, &c.); and it is therefore true in this acceptation that the arctic man would be more likely to freeze upon vegetable than animal food, despite of the superabundance of carbon in the former (§ 447, *h*). But, as I have said, and shown, he may, by the mere force of habit, come to endure the cold nearly as well upon vegetable as on animal diet (§ 442 *b*, 535, &c.).

I will also say, that it is a vulgar prejudice that "train oil and tallow candles" are appropriate food for man in any climate (§ 440 *b*, no. 9). The arctic, like every other man, would soon perish upon these indigestible substances. They would yield him neither flesh nor "fuel." And, having thus come again upon the philosophy of "fat" as a source of heat when taken into the stomach (§ 440, *bb*), the chemist is evidently embarrassed by the contrast which is presented by certain graminivorous and carnivorous animals (§ 440, *i*); and so he clears the way by the following assumptions, which have only reference, also, to a limited number of two genera of animals (§ 440, *cc*). The conclusion of the extract is a good specimen of our author's mode of disposing of former observation, and a profitable commentary upon what is requisite in "experimental philosophy" (§ 350, mottoes *a–e*, and no. 28). Thus:

"*We know*, in fact, that the graminivora expire a volume of carbonic acid equal to that of the oxygen inspired, while the carnivora, the only class of animals whose food contains fat, inspire more oxygen than is equal in volume to the carbonic acid expired. *Exact* experiments have shown, that in *many* cases only half the volume of oxygen is expired in the form of carbonic acid [350½ *n*, 440 *f*, nos. 17 and 18, 447½ *f*]. These observations cannot be gainsayed, and are far more convincing than those *arbitrary and artificially* produced phenomena, sometimes called experiments [by the "digestive mixture," retorts, acids, lamp-wick, &c.?]; experiments which, made, as too often they are, without regard to the necessary and *natural* conditions, possess no value, and may be entirely dispensed with; especially, when, as in the present case, *Nature affords the opportunity* for observation, and when WE make a rational use of that opportunity."

It remains only to say of the foregoing, that the chemist was not duly mindful of the fact that all the principal tenants of the deep, warm-blooded and cold-blooded, are alike carnivorous; and that the exalted temperature of the blubber-whale, the porpoise, &c., breathing, also, with lungs, and in their comparison with the low temperature of their associates that respire with gills, contrasts forcibly with those carnivorous animals whose respiration of oxygen is said to prevent an accumulation of fat. Such, I mean, is the fundamental doctrine of "fat" (§ 440 *bb*, no. 10). But since animal food, especially fat, contains more of the "fuel" than vegetable food, how does it hap-

pen, according to the foregoing statement as to the relative proportions of oxygen consumed and carbonic acid expired by the graminivorous and the carnivorous animal, respectively, that the former should surpass the latter in the formation of fat?

Wherever, therefore, we look at the "facts" of the organic chemist, we find ourselves not only in the midst of contradictions, but employed in refuting assumptions that are opposed by universal experience (§ 5¼). That experience I had employed in the *Commentaries* for the very purposes to which its adverse assumptions are now consecrated by the disciples of the "improved philosophy" (§ 349 *d*, 350¼).

441, *d*. In the case of the hibernating animals (§ 441, *c*), the excessive cold, and mechanical irritation, in rousing the calorific function, operate as a stimulus to the vital properties, and thus restore the organic functions, and the natural temperature as a consequence, along with the other organic products; though the heat more perfectly than any other. In a less degree, cold is a sedative to the hibernating animals (§ 188½, 743). This, also, is an example illustrative of the opposite influences of vital agents, according to their intensity of action, and the circumstances under which they are applied, and of the wonderful adaptation of the natural agents of life to the peculiarities of particular species of organic beings (§ 191, 446 *d*, 500 *o*).

The impression of cold, or mechanical irritation, in the foregoing case, is transmitted from the skin to the cerebro-spinal axis, where the nervous power is developed and radiated abroad upon the organic properties of the entire body, by which they are brought into operation (§ 222–233, 500, 512, &c., 638).

Respiration and other organic functions nearly cease during the state of torpor; but the restoration of heat is far more than commensurate with the progressive return of respiration. Of all the products, an evolution of heat takes the lead, as indispensable to the other important results. This appears to have been seen by Liebig. Nor is there any principle in physiology, nor any facts, which will at all explain the operation of cold in diminishing respiration, or circulation, till it has first reduced the temperature of the surface. And, were the chemical hypothesis true, the hibernating, and the young of other warm-blooded animals, should not sustain the remarkable reduction of heat which is produced by an atmospheric temperature of 45° F., since more oxygen is then consumed than at higher temperatures. There can be no such positive exceptions to a fundamental law. If peculiarity of constitution be assigned as the cause, then is the chemical hypothesis abandoned, and the vital theory admitted.

It is therefore apparent, that the reduction of temperature depends essentially on other causes than diminished respiration. The converse of this must be equally true; and when heat, therefore, is restored, the first step in the process is an increased action of the capillary blood-vessels, through the stimulus of the nervous power (§ 222, &c.), by which an evolution of heat is immediately started; and then begins an increase of the respiratory movements. "We can always hasten respiration," says Bichat, truly, "by making an animal suffer; but an acceleration of the pulse is always prior to that of respiration, which appears to be determined by it."—(See § 484, Exp. C.)

441, *e*. That is a test. If the heat rises without oxygen, it certainly does not, in such a case, depend upon combustion. The "carriers"

must be regularly supplied (§ 447½, *a*). I have said that Liebig appears to have been sensible that internal heat is important to the organic processes, though vastly more so in the warm-blooded than the cold-blooded race, and his statement upon this subject is one of his numerous contradictions of the hypothesis which he assumes. Thus:

"It is obvious that THE CAUSE OF THE GENERATION OF FORCE is diminished, because, with *the abstraction of heat*, the intensity of *the vital force diminishes*. It is also obvious, that the *momentum of force* in a living part *depends* on its proper temperature." "The increase of mass is effected in living parts by the *vital force*. The *manifestation* of this power is *dependent on heat;* that is, on a certain temperature peculiar to each specific organism." "The abstraction of heat must be viewed as quite equivalent to a diminution of vital energy."—LIEBIG'S *Animal Chemistry*.

Now, according to this reasoner, "in the animal body we recognize as the *ultimate cause of all force* only *one* cause, the *chemical action* which the elements of the food and the oxygen of the air mutually exercise on each other."

We are also told that "the mutual action between the elements of the food and the oxygen conveyed by the circulation of the blood to every part of the body is the *source of animal heat*."—LIEBIG'S *Animal Chemistry*.

But, we have just seen that the same reasoner affirms that these very movements are "dependent on heat" (§ 350, no. 17½, &c.). The cause depends upon the effect, and the effect depends upon the cause (§ 440, *f*). And how could it be otherwise with an hypothesis so estranged from nature? Indeed, our author not unfrequently quits, entirely, the chemical ground of animal heat, as we have seen of many other assumptions (§ 350), and gives way to the simple dictates of nature. For example,

"Certain other constituents of the blood may give rise to the formation of CARBONIC ACID in the lungs. But, all this has NO CONNECTION with that VITAL PROCESS BY WHICH THE HEAT necessary for the support of life IS GENERATED in every part of the body."—LIEBIG'S *Animal Chemistry*.

And yet it is both a doctrine of this philosopher in physiology and medicine, that the evolution of animal heat is a purely chemical process, and that carbonic acid cannot be formed in the body without the disengagement of heat (§ 350, no. 17½; § 440, no. 17). Taking, also, in connection the two parts of the foregoing quotation, we have one of those palpable contradictions of a fundamental assumption which are the never-failing characteristic of false doctrines. There is the double affirmation that carbonic acid resulting from any other source than a vital process is not a cause of animal heat, and that animal heat is alone generated by a vital process. (See, particularly, § 440, nos. 6 and 16.) Or, allowing what the language does not admit, the dependence of animal heat upon carbonic acid "generated in every part of the body," we should then have the curious phenomenon in chemistry of the production in the animal body of carbonic acid by a chemical process and by a vital process, while that of the former, the very gist of the doctrine, does not, as avowed, contribute to animal heat.

441, *f*. Again, it is reiterated, that "the mutual action between the

elements of the food and *the oxygen conveyed by the circulation of the blood* to every part of the body is the source of animal heat" (§ 350, no. 3).

Now, frogs have a feeble power of generating heat, as have "all living creatures, whose existence depends on the absorption of oxygen" (§ 443, *c*). But, these animals contradict our author's hypothesis as to the "carriers of oxygen," not only in its relation to animal heat, but other important matters, such as the production of *force*, of *motion*, &c. (see § 350, nos. 3, 4, 8). Spallanzani, for instance, eviscerated the heart, large blood-vessels, &c., of a number of frogs and toads, and buried them in the snow, along with others which retained their circulation and vivacity. The whole soon became completely torpid, and "appeared as if frozen." In a few hours they were all removed to a warm situation, where all of them began to leap and make their escape; the reanimation being apparently as perfect in those which had been deprived of blood as in those which had not. When exposed to greater degrees of cold, they perished in equal times (§ 441½ *d*, 443 *b*, 494).

How simple an experiment, therefore, may overthrow the most popular hypothesis in philosophy. It cannot be true of frogs that will leap and jump without blood, as well as frogs with blood, after being "apparently frozen," that their independent source of heat is owing to "the oxygen conveyed by the circulation of the blood," any more than their "*amount of motion* is proportional to the quantity of oxygen inspired and consumed in a given time by the animal" (§ 350, no. 8). And then, too, according to our author,

"Since physiology has proved, that the globules of blood take no share in the process of *nutrition*, *it cannot be doubted* that they play a part in the process of *respiration*." Especially in white-blooded animals.—LIEBIG'S *Animal Chemistry*.

From all which it is more and more apparent, that "the Reformer" was employed about a plan of human chemistry rather than of animal chemistry (§ 440, *c*).

The foregoing subject is farther continued in § 443–445.

441½, *a*. What has been said in the preceding section of the hibernating and cold-blooded animals is true, in principle, of all other animals who suffer only a partial reduction of temperature. The differences do not arise from different fundamental laws, but from different modifications of the properties of life in different species of animals, and at different ages of the same individual (§ 155, 185, 191). There are many animals that approximate the hibernating in their feeble power of maintaining heat; and others, again, which sustain intermediate relations to the more perfect of the warm-blooded vertebrata. "The high temperature," says Edwards, in his *Influence of Physical Agents on Life*, "which seems to characterize the mammalia and birds, does not belong to them exclusively, since examples of it are found among insects; and, on the other hand, among the mammalia themselves (as the hibernating), which, at certain periods, present the principal phenomena of the cold-blooded vertebrata; and, lastly, a great number of non-hibernating mammalia and birds, in the early periods of their life, show, as far as the phenomena of heat are concerned, a strong resemblance to the cold-blooded animals."

It may be thence inferred, that what is so remarkably conspicuous

in the torpid hibernating animals is only the result of a law that prevails throughout the animal kingdom. This law extends equally to the vegetable kingdom, which possesses a far greater power of generating heat than frogs and other cold-blooded animals. The trees and shrubs which belong to northern climates have, also, exactly the peculiarity of the hibernating animals, while those of tropical regions maintain a greater uniformity of temperature, and are destroyed by a degree of cold in which some northern herbaceous plants spring into active life, and pierce their way through snow and ice.

441½, *b*. And this leads me to say, that, through the same law, the warm-blooded vertebrata have their standard of heat modified by climate; and even man himself sustains variations of 1° to 2° F. And, as I have said in my former Essay on *Animal Heat*, it is important to remark, as showing the entire independence of this phenomenon of respiration, this change does not take place till such as remove from one climate to another shall have been for some time subjected to the new condition of vital stimuli. It is the result of acclimation, and, trivial as it may seem, it is full of the most instructive illustration to a reflecting mind. The phenomenon, I say, is owing to permanent modifications of the vital constitution, and is of the same nature as the change of temperament which the melancholic undergoes on passing from the temperate to the equatorial regions (§ 602), and about which the law of vital habit is interested (§ 561, 585, 602, 603).

441½, *c*. It is equally a fatal circumstance to the chemical hypothesis, that the standard of heat is lowest in cold, and highest in hot climates, whatever the amount of clothing, &c., since more oxygen is respired in the former, and, according to our author, a far greater quantity of "fuel" is consumed both by the mouth and by oxygen gas (§ 440, nos. 8, 9, &c.). It is not difficult, therefore, to understand the bearing of the following statement:

"The most trustworthy observations prove that in all climates, in the temperate zones as well as at the equator or the poles, the temperature of the body in man, and in what are commonly called warm-blooded animals, *is invariably the same*."—LIEBIG'S *Animal Chemistry*.

And why, again, is the temperature of man higher in tropical than in temperate climates? The reply is another proof of the tampering of chemistry with a subject utterly beyond its reach; since the heat of the tropics operates gradually as a vital stimulus to the calorific function, and thus slowly establishes that condition by which an exalted temperature is determined throughout the universal body (§ 350, no. 65, 441 *c*, 445 *e*).

441½, *d*. Nor may I neglect the striking characteristic of the egg, which possesses the power of resisting cold "in a degree equal to that of many of the inferior animals." This is one of the facts which led Mr. Hunter to believe that the vital properties are capable of generating heat independently even of circulation (§ 441, *f*), while its greater evolution is seen to be the result of those properties in active operation through the mature organization (§ 65). The former condition, associated, also, with the power of resisting the causes of putrefaction, is a beautiful illustration of the nature of life, that it is an active, not a passive state, that it consists essentially of power, and that its laws are specific. But, how will the combustion hypothesis dispose of the internal source of heat in the egg?

442, *a*. In respect to the affirmation that "clothing is merely an equivalent for a certain amount of food" (§ 440, no. 11), I have adduced, in my former Essay, many facts to prove that our clothing is greatly a matter of habit, and this is shown by the facts which will be soon presented. It is, indeed, a forcible illustration of the nature of the properties of life, of the dependence of animal heat upon vital action, and of its obedience to the law of vital habit, and to the constitutional law by which all results shall be so regulated as to maintain the integrity of organic processes, and, therefore, a uniform temperature of non-hibernating warm-blooded vertebrata; while, as I have endeavored to show in the same work, the modifications of these processes in hibernating and cold-blooded animals, as well as in the vegetable kingdom, are not only perfectly consistent with what is observed of the non-hibernating warm-blooded vertebrata, but go to confirm the whole philosophy which is founded upon the phenomena of these animals.

There, too, I have shown by an examination of facts, that the rapid change in the power of elaborating heat in early life depends on the same common principle which determines the changes in all other functions and results, that they are all on a par in principle, and that the rapid increase of the resistance of cold in the young of the warm-blooded vertebrata proves the vital character of the calorific function (§ 153–159, 441 *b*).

442, *b*. In illustration of the law of vital habit as it respects the power enjoyed by man of resisting cold (§ 441, *c*), and in farther disproof of the assumption that a living animal is "like any other heated mass in relation to the temperature of surrounding objects," I shall quote from the *Commentaries* one of the facts which are there presented for the purpose which is now in view. Thus:

"Mackenzie says, that some of the northern savages follow the chase in the coldest weather with only a slight covering. Lewis and Clark state, that two Indians slept upon the snow during the night in a light dress, when the thermometer was 40 degrees below the zero of Fahrenheit. The man was uninjured; the boy had his feet frozen. Now it is evident that no civilized man could sustain such an exposure. The phenomenon is owing to *the power of habit* in relation to the forces of life, and is utterly insusceptible of explanation on any other principle."—*Commentaries*.

On the other hand, an individual froze to death in the woods of Peacham, Vermont, on the night of the 7th of June, 1817; notwithstanding, also, he was full, to intoxication, of the most combustible substance (§ 440, no. 9).

But, again, we are informed by Captain Wilkes, that, when the thermometer was at 40° F., "the Petcherai Indians were entirely naked, with the exception of a small piece of seal-skin, only sufficient to cover one shoulder, and which is generally worn on the side from which the wind blows, affording them little shelter against its piercing influence."

Again, says Captain Wilkes, "On the 11th of March, three bark canoes arrived, containing four men, four women, and a girl about sixteen years of age, four little boys, and *four infants*, one of the latter about a week old, and quite naked. The thermometer was at 46°

Fh."—WILKES's *Narrative of the United States Exploring Expedition*, vol. i., p. 121, 124. 1845.

The foregoing, in relation to the *infants*, should be considered in connection with what has been ascertained by Dr. Edwards as to the comparative inability of infants to bear a cold atmosphere, when unaccustomed, and with what is known of hereditary constitution (§ 447 *h*, 540, 561. See, also, *Medical and Physiological Commentaries*, vol. ii., p. 27, 52, 56, 69–74).

"The power of the Russian Zincali of resisting cold," says Barrow, "is truly wonderful, as it is not uncommon to find them encamped in the midst of snow, in slight canvas tents, when the temperature is 30° or 40° below the zero of Fahrenheit."—BARROW's *Zincali of Spain.*

No two individuals under apparently equal circumstances, of the same health, age, sex, and with the same quantities and qualities of food, clothing, &c., are alike in the power of resisting cold. Place them in a temperature at zero of Fahrenheit, and one will perish while the other will not suffer. One shall enjoy a glow of warmth from athletic exercise, while the other shall perish with the same counteracting means. It is a common event to witness the blasters, in the vicinity of New York, at work in winter with heavy drills in their naked hands, while others, unaccustomed, would be frost-bitten at the same temperature. The difference is manifestly owing in part to a difference in constitution, but especially to the influence of *habit*, which engenders the power of enduring intense degrees of cold, and which no chemical principles can possibly expound (§ 535–568).

442, *c*. The foregoing facts show us, also, how it has happened that animals have spread abroad from the spot where they were created, and become specifically adapted to different climates. The element of their adaptation was implanted in their vital constitution at the time of their creation, and relates to almost all physical agents. And so with vegetables, which may be gradually transplanted from the equator to high northern latitudes, where they also undergo changes of organization (§ 155, 535, 538, &c.). Thus do we also again bring the philosophy of physiology to the overthrow of that infidelity which departs from the Mosaic account of organic Creation (§ 74, 450¾, *h–n*).

442, *d*. Again, do the beasts or the birds of the polar clime change their fur or their plumage, when transported to a temperate region? What, for example, answers the white bear, with which we are all familiar? And yet their temperature sustains but a slight change, though a change subversive of the combustion theory (§ 441 *c*, 441½). Here, too, in truth, they consume a far greater quantity of food; and, if the chemist's hypothesis as to an interchange of caloric with the atmospheric air be adopted (§ 440, no. 14), these transplanted creatures should sustain a very exalted rise of temperature. But, upon the physiological action of external heat, as a vital stimulus, the high temperature of a warm climate would much more than compensate for any supposed deficiency of oxygen (§ 440 *e*, 441½ *c*).

"And then, on the other hand," turning again to man, and as I have said in the Commentaries, "are the experiments of individuals subjecting themselves to an excessively high temperature, without sustaining any sensible variation of heat. This was fully demonstrated by Blagden, Banks, Fordyce, Solander, G. Home, Dundas, Dr. North, Phipps, Seaforth, and Dobson, who exposed themselves to a temperature of 260° Fh."—*Comm.*, vol. ii., p. 61, 62.

442, *e.* We see, then, in the various demonstrations, which have now been made, of the power of all warm-blooded, non-hibernating vertebrata to maintain a uniform degree of heat under the greatest vicissitudes of atmospheric temperature that are compatible with life, a proof of a most astonishing law of the living body, in perfect conflict with the laws of caloric as they exist in the inorganic world. "We know it" as exactly as we comprehend the nature and operation of the most precise law in physics. It is, in itself, demonstrative of the government of living beings by specific forces. It establishes a positive distinction between these forces and the organized structure. If I am not right in this construction, I say, once more, let the ground of objection be shown. I mean not the usual denial, or by renewed misrepresentations of my statements. The objections must be founded upon a broad and philosophical survey of all the phenomena of heat that relate to living objects as they may be modified by natural causes, or by morbid states of the system; and the ground must cover the general physiological condition of organized beings. How wide from all this are the assumptions, and those mostly relative to man (§ 440, *c*), that have been lately consecrated as the true "experimental philosophy" of animal heat (§ 349, *d*)!

443, *a.* As my former Essay embraces an extensive range of inquiry into the facts and philosophy attending the calorific function in the cold-blooded race, I shall now add only a few remarks to what I have already stated upon this subject, and as suggested by the present stage of my inquiry (§ 441 *f*, 441½ *a*).

443, *b.* Frogs and other cold-blooded animals are supplied with capacious lungs; and, however it may be argued that their consumption of oxygen is less than that of warm-blooded animals, they have, nevertheless, the same respiration, nutrition, vital decomposition, and the same "charcoal fire," in the ratio of the food consumed, and yet is their temperature principally regulated by that of the surrounding medium. They also emit a large amount of carbonic acid, which proves a free consumption of oxygen and a liberal supply of food. All this is as essential to frogs as to man; and they equally perish when deprived of atmospheric air, and so of all the cold-blooded finny tribe (§ 350, no. 17½, and § 440, no. 10). And what will chemistry answer to the exalted temperature which attends the inflammations of the cold-blooded vertebrata?

Chemistry must here be consistent, and in being so it necessarily abandons the hypothesis that the evolution of heat, in warm-blooded animals, depends on the union of oxygen with the carbon and hydrogen of the body, and that it occurs in the ratio of that combination. "*In the animal body,*" says Liebig, "*the food is the fuel; with a proper supply of oxygen we obtain the heat given out during its combustion.*" (Also, § 440, nos. 5, 6, 17.)

443, *c.* The difference in the law regulating temperature is owing to a difference in vital constitution, of which the chemist takes no account (§ 440, no. 12). But, there are also many other peculiarities in the vital phenomena of cold and warm-blooded animals which are due to the same condition of constitution, and by which their relative power of generating heat is shown to depend on a common cause, and which is common to all the phenomena. It is this which renders cold-blooded animals greatly subject to the temperature of the

surrounding medium, but which also enables them to resist its influence by some 2 or 3 degrees at all seasons of the year.

443, *d*. If the chemist resort to difference of constitution in explaining the foregoing phenomena, as is generally done, he resorts to the properties and functions of life, and abandons his own ground. In one case he says, it is because they are cold-blooded, and in the other, because they are warm-blooded, and so on. Such, indeed, is the fact. But, is it not because the organization and vital endowments are not adapted to the same generation of heat in one case as prevails in the other; and this, too, when the organization may be in a high degree simple (§ 409, *e*)?

444. Let us, therefore, settle this question by reference to an animal without lungs, or gills, and in which, also, the temperature is clearly influenced by causes which can alone operate as vital stimuli. The temperature, for example, of a hive of bees is at about 90° F., when the air is at 40°, and upward of 70° in winter. Their power of generating heat is also increased during the breeding season. This phenomenon corresponds with the observations that I have made upon vegetables; having found the temperature highest when the leaves and blossoms are putting forth.—(*Medical and Physiological Commentaries*, vol. ii., p. 75–78.)

445, *a*. Still more conclusively, than the obvious dependence of organic heat in the cold-blooded vertebrata, insects, &c., upon vital principles, do the phenomena of vegetable heat evince the same great law of organic nature. This subject has been ably explored by John Hunter, and, as I have intimated in the foregoing section, has received a careful attention from myself. Senebier, also, saw the thermometer rise from 79° to 143° F., when placed in the midst of a dozen spathes of the *arum cordifolium*, at the time of opening their sheaths. And so Huber, and others.

445, *b*. That fact, and the ability of plants to generate a temperature often far above the earth or the surrounding atmosphere, are so apparent that they are universally admitted; but obtain from the chemist no farther notice. Indeed, the following is all that we have from Liebig on the subject of vegetable heat. Thus:

"All living creatures, whose existence depends on the absorption of oxygen, possess within themselves a source of heat independent of surrounding objects. This truth applies to all animals, *and extends, besides, to the germination of seeds, to the flowering of plants, and to the maturation of fruits*."—*Animal Chemistry*.

And yet is the "combustive process" always in progress, more or less, in all parts of vegetable organization. The question, therefore, arises as to the motive for not only concealing an important fact, but in thus implying, by circumstantial statements, that no other parts of vegetables "possess within themselves a source of independent heat." The very fact that such a source belongs to seeds in their germinating state, &c., is sufficiently conclusive that it extends to every part of the plant, and "the Reformer" could not have been ignorant that the very egg resists a temperature below the freezing point in virtue of its internal source of independent heat.

But, all this is fatal to our author's hypothesis. Eggs do not consume oxygen, have no "carriers of oxygen," and trees, it is said, do not "burn" like the animal body (§ 302, 303$\frac{2}{3}$). Consequently, the

chemist, to carry out his hypothesis of animal heat, must maintain the anomaly that seeds, flowers, and fruits, during their development, are the only parts of the vegetable world that possess "an independent source of heat." The secret of all this will be farther seen in the following passage:

445, *d.* "The distinguishing character of vegetable life is a continued passage of matter from the state of motion to that of static equilibrium. A plant produces within itself *no cause of motion*" (see § 350, nos. 7, 8, 10, and § 440, nos. 5, 6, 8, 9, 12, &c.). "In a word, no waste occurs in vegetables. [?] Waste, in the animal body, is a change in the state or in the composition of some of its parts, and consequently is the result of chemical action." — LIEBIG's *Animal Chemistry*.

And, again: "Analogy, that fertile source of error, has unfortunately led to the very unapt comparison of the vital functions of plants with those of animals."—LIEBIG's *Organic Chemistry*, &c.

445, *e.* Thus is the problem solved. There is either no heat generated by plants, or, otherwise, the chemical doctrine of animal heat is radically false. To show how this may be, I shall now introduce an abstract of some observations made by myself on the temperature of trees. It is unnecessary to state the mode in which the observations were conducted, or the precautions adopted, as they are recorded in the *Commentaries*.

On the 9th of April, 1839, in a neighboring forest, the following results were obtained:

"Range of the thermometer in the shade, during the observations, which lasted six hours, from 38° to 52° F. Near freezing at sunrise.

"A dead upright tree was selected as a standard of comparison. Its diameter was 12 inches. The temperature of this tree, at the close of my observations, was 45° at the centre and in all other parts (§ 440, nos. 14, 15, and 16).

Juglans squamosa,	diameter	10	inches,	48°	Buds slightly enlarging.
Do. do.	"	6	"	49°	do.
Fagus sylvatica,	"	10	"	49°	Buds swelling.
Quercus tinctoria,	"	7	"	49°	No budding.
Castanea Americana,	"	12	"	50°	do.
Betula nigra,	"	4	"	51°	Flowering.
Salix Babylonica,	"	18	"	53	Buds unfolded.
Do. do.	"	18	"	53°	do.
Pinus Canadensis,	"	18	"	54°	
Platanus occidentalis,	"	18	"	50°	No budding.
Do. do.	"	6	"	54°	do.
Do. do.	"	4	"	55°	do.
Juniperus Virginiana,	"	4	"	55°	
Robina pseudacacia,	"	3	"	62°	do.
Populus lævigata,	"	4	"	62°	In bloom.
Do. do.	"	4	"	64°	do.
Do. do.	"	3	"	63°	do.
Do. do.	"	3	"	65°	do.
Do. do.	"	2	"	67°	do.
Do. do.	"	$1\frac{1}{2}$	"	68°	do.

"Believing that if the vital doctrine of the generation of animal heat were correct, I should find an elevation of vegetable heat as the warmth of the season increased, and the energy of vegetable life became more exalted, on the 19th of the same April I made another visit (§ $441\frac{1}{2}$, *c*).

"Range of the thermometer in the shade, during the observations, which lasted five hours, from 40° to 65°

"Temperature of two dead, dry, upright birch trees, one eight inches in diameter, the other six inches, at end of observation 60° in all their parts. Temperature of the earth six inches below surface 47° in shade, at close of observation. Probably 50° at two feet.

Betula nigra,	diameter 15 inches,	54°	Buds swelling.
Platanus occidentalis,	" 6 "	59°	do.
Quercus virens,	" 8 "	62°	do.
Do. do.	" 2½ "	73°	Buds much more advanced.
Do. tinctoria,	" 18 "	65°	Buds swelling.
Do. do.	" 6 "	66°	do.
Juniperus Virginiana,	" 5 "	64°	
Do. do.	" 2 "	79°	
Acer rubrum,	" 12 "	65°	In bloom.
Castanea Americana,	" 4 "	66°	Buds swelling.
Cornus Florida,	" 2 "	68°	Flower-buds advancing; no leaves.
Fagus sylvatica,	" 12 "	68°	Buds opening.
Juglans alba	" 4 "	75°	Buds swelling.
Do. do.	" 1 "	83°	Buds larger.
Do. do.	" ¾ "	82°	Buds opening.

445, *f.* "It is abundantly manifest from the foregoing observations that vegetables possess a vital power of generating heat, according to the activity of their organic forces; and I carry the analogy to the animal kingdom. The temperature was not influenced by that of the earth, as seen by the preceding statement. The heat of the latter, however, was not ascertained at the first observation. It appears, also, that the power of generating heat is greater in proportion to the youth of trees. This remarkable fact is not only especially indicative of the vital agencies in the generation of vegetable heat, but is worthy of notice on account of its opposition to what obtains in the animal kingdom in respect to age. It corresponds, also, with observations upon herbaceous plants. The difference depends upon the relative difference in organization and vital properties at the corresponding periods of life."—*Commentaries* (§ 153–155, 441 *b–i*).

445, *g.* It is a fundamental principle, therefore, that "*the general phenomena of the disengagement of heat remain always the same in animals with lungs, in those without them, and in plants, all of which have an independent temperature.*"—BICHAT.

446, *a.* The relation of the nervous power to animal heat is the same as that of all other products of animal organization; its influence, however, being sometimes remarkably pronounced in the elaboration of heat, as seen in the quick transition of the hibernating animal from temperatures below 40° to upward of 90° F. This subject, however, has been so extensively investigated in my former work, that I shall only now say that the elaboration of animal heat does not depend on the nervous power, as often maintained, but, like other functions of animals, is only influenced by it (§ 183–185, 188, 222–233, 489, 492, 500). These are variously affected by varying influences exerted upon the cerebro-spinal and ganglionic systems, as, of course, are also the secreted products in a corresponding manner. In the perfectly natural state, the nervous system has no important agency in the production of the phenomena, but may become powerfully instrumental in modifying the properties, and actions, and products of life, when unusual conditions exist, or when unusual impressions are transmitted to the cerebro-spinal axis. We have seen, too, that analogy, as supplied by the vegetable kingdom, affords the strongest presumptive evidence that the nervous system may have no active participation in the elab-

oration of heat, in the natural condition of the body, while this induction is strengthened by what is known of other secreted products in both of the animated kingdoms. Still, in respect to the animal kingdom, the mere existence of the cerebral and ganglionic systems, their remarkable properties and susceptibilities, and their intimate connection with all parts of the organization, is, *prima facie*, conclusive that they have important offices in relation to animals, and that their presence, in the natural state of the complex being, is indispensable to the integrity of every function. This, as will have been seen, has been experimentally ascertained in relation to many; and that unusual, or sudden impressions that are not unnatural, as the operation of the passions, for instance, may be extensively and profoundly propagated from the brain to other organs. It has been fully demonstrated that the natural condition of the secretions depends upon the integrity of the nervous connection between the secerning organs and the cerebro-spinal axis; while it has been equally shown that the organic functions, and all vascular action, may be immediately and powerfully influenced by impressions made upon the brain and spinal cord, whether in a direct manner, as in Philip's Experiments, or indirectly through the medium of sympathy, as in blows upon the stomach, surgical operations, the action of medicines and of poisons upon the intestinal canal, &c.

Assuming, then, that animal heat is also a secreted product, it would come philosophically under the common law; and since it appears from experiment, that animal heat depends even more upon the presence of the brain than an imperfect production of gastric juice and other secreted fluids, and may be as powerfully influenced through the nervous system, the physiological analogy between heat and other secreted matters becomes quite apparent; while it explains the remarkable effect of a low atmospheric temperature in developing heat in the torpid hibernating animal (§ 441, 441½ *a*); and thus conducts us, also, to the philosophy of the operation of other causes in modifying animal temperature.

To maintain the foregoing conclusion, I have examined, in my former Essay, the merits of Brodie's, Philip's, Chaussat's, and other experiments upon the nervous system, the phenomena of hibernating animals, the modifications of temperature that spring from injuries, diseases, and other affections of the nerves, &c., the admissions of distinguished chemico-physiologists, and other important considerations. Some of these facts in relation to the nervous influence upon animal temperature will appear in the next following section.

446, *b*. It should be said, however, that it has been stated by some that the experiments of Philip conflict with those of Brodie and Chaussat, which establish an influence of the nervous power over the phenomena of animal heat. But that is an error; since the deduction of Philip himself from his own observations ascribes to the nervous power what is due to the organic power. Thus:

"That the maintenance of animal temperature is a function of the nervous system, properly so called, appears from a variety of facts generally known; the temperature either of a part or of the whole body being lessened by any cause that impairs the action of particular nerves in the former instance, or of the whole nervous system in the latter."—PHILIP, *on Acute and Chronic Diseases*, p. 48.

Again he says, "I here consider it as proved, by experiments already laid before the reader, that the evolution of caloric is a function of the nervous influence."—PHILIP'S *Inquiry into the Laws of the Vital Functions, Exp.* 77. (Also, § 437, *c.*)

446, *c.* It is, of course, erroneously stated by "the Reformer," that, "by the division of the pneumogastric nerves, the motion of the stomach and the secretion of the gastric juice are arrested." The juice is only modified in quality, while it is actually increased in quantity (§ 461, 489).

"The Reformer" has also high conceptions of the agency of the nervous system in organic results, notwithstanding they are all exclusively due, in his estimation, to the merest chemical processes (§ 350). "Every thing in the animal organism," he says, "to which the name of *motion* can be applied, proceeds from the nervous apparatus." Our author, however, is entirely mistaken in his opinion that "*the singular idea* that the nerves produce animal heat has obviously arisen from the notion that the inspired oxygen combines with carbon in the blood itself." Nevertheless, we are told by our author that "*every thing in the animal organism* to which the *name of motion can be applied proceeds from the nervous apparatus;*" and we are also told that without this motion there can be no animal heat (§ 350, nos. 3, 17½, 6, 7, 18½, 19).

But, take the ordinary construction of those who mingle together, but virtually contradistinguish, the powers and processes of living and dead matter, and impute to the nervous influence no small share, along with chemical agencies, in the production of heat and other products of the living organism, we are asked to sanction one of the most unphilosophical and incongruous medleys of powers, processes, laws, and principles, acting and reacting upon each other, that ever presented itself for well-merited satire. The nervous power is also apt to be regarded by the chemico-vitalist, as by the chemist, a mere chemical agent. But, we shall have seen that this construction is encumbered with difficulties (§ 222, &c., 451 *f*, 500 *n*).

446, *d.* The modifying influence of the nervous system upon the generation of animal heat being established not only by experiments, but especially, also, by facts relating to morbid states of the system, to which I shall soon advert, and by all that is philosophical in physiological science; and when we consider, also, how easily and rapidly the nervous influence may be determined upon the vascular system (as in blushing), and upon the organic viscera, we have an intelligible explanation of the operation of a very low degree of cold in recalling into action those vessels upon which depends the exaltation of temperature in the torpid hibernating animal (§ 441 *d*, 441½ *a*). That the intensity of the cold, like the mechanical irritant (§ 441, *c*, *d*), operates, also, in a direct manner, upon the *organic* properties, as in other instances of foreign agents, is undoubtedly true (§ 189). The law being also universal, explains the influences of other causes, in health and disease, in modifying animal temperature, and only regards the agency of *respiration*, like that of digestion, &c., as being instrumental in perfecting the blood, and thus adapting it to the uses of the various organs which are concerned in the elaboration of heat and other products.

447, *a.* Whatever is true, in a fundamental sense, of the production

of heat in the natural state of the organic being, must be equally so in its morbid conditions. It is true, we are told by "the Reformer," that "*we cannot investigate the laws of life in an organized being which is diseased;*" but we have seen that this will not hold in experience or philosophy (§ 303$\frac{2}{3}$). It serves, however, its useful purpose in the chemical doctrine of animal heat. But, since the truth is just the reverse (§ 160, 163), I shall present from the *Commentaries*, in this section, a series of facts which contribute an important light upon the physiology of calorification, and upon the general constitution of organic beings. We shall learn yet farther, by this demonstration, that the evolution of animal heat is exactly on a par with all other organic products, and has a corresponding dependence upon decarbonized blood, and can be regarded in no other aspect (§ 764, *c*). And here our author's philosophy is consistent, since he imputes alike the formation of animal heat, and all other products, even the circulation of the blood, nay, all diseases, yea, death itself (§ 350, no. 46), to the union of oxygen gas with the elements of food.

447, *b*. Indeed, it cannot be too often said, as shown by the question before us, that the phenomena supplied by diseased conditions are often the most important in illustrating the properties and laws of organic beings; and upon no question have they a greater bearing than the one under consideration. Morbid states are only physiological changes, and the resulting products and phenomena are simply modified conditions of such as are more natural, and are dependent upon the same laws, the same causes, the same functions as determine the healthy results (§ 155, 156). This is an undeniable proposition. In the conflict of doctrines, therefore, which are predicated of the perfectly natural phenomena, we should seek for the light of such as emanate from diseased conditions; and here the chemist is even more disqualified for investigation than in the dark mazes of physiology. To him, the vast field of pathology, which every where stamps with falsehood his chemical views of life, is as hidden as undiscovered regions; and since all pathological and therapeutical conclusions necessarily refer to the natural physiological conditions, their impracticability, absurdity, and destructiveness, when deduced from the chemical premises, as clearly demonstrate the shallowness of their foundation. The student of organic nature, therefore, appreciates, as he deplores, the ignorance which is received as the light of knowledge (§ 349, *d*).

447, *c*. It should be considered, also, in respect to the vast differences in temperature that spring from morbid conditions, whether high or low, the diet is often the same, very spare, or when the temperature is most exalted, as in active forms of fever and inflammation, there is a total abstinence from food. Consider, also, the brute animal under the same circumstances, abstaining totally, yet suffering a very exalted temperature (§ 440, nos. 1, 4, 5).

I shall proceed, therefore, to a statement of some of the important facts which are supplied by disease, as set forth in my former Essay on Animal Heat. For the authorities quoted, see the Essay.

447, *d*. Diseases of the brain supply a variety of facts which illustrate our inquiry. Thus, in phrenitis, one arm, or one side of the body, is colder than the other. "That the temperature of a paralyzed part is generally below the normal standard is now universally admit-

ted." That this is owing to impaired vitality, is also shown by the frequent failure of nutrition in the paralyzed part, as well as other coincident phenomena. In a case related by Mr. Earle, he found the temperature at 70° F., in the hand of a paralyzed arm, while that of the opposite hand was 92°. He could also effect a temporary restoration of temperature by electricity and by blisters. "The circulation of the blood did not appear to have suffered, the pulse at the wrist being synchronous, and equally strong with that of the other limb." In an injury of the sympathetic nerve, Chaussat saw the temperature fall from 104·88° to 78·8° F., in ten hours.

On the other hand, there is a remarkable exaltation of temperature in a part at the invasion of *tic douloureux.* So, when the nerves are mechanically injured. There was a patient at St. George's Hospital, whose temperature rose 11° F., in consequence of an injury of the spinal column; and this took place when the respirations did not exceed *five or six in a minute.* It is stated by Dr. Macartney and other observers, that when the principal nerve of an extremity is divided, the temperature of the limb is immediately exalted several degrees. The philosophy of this is well expounded by an advocate of the chemical doctrine. "We should be disposed," he says, "to regard it as due to the temporary excitement of the molecular changes by the irritation produced by the section of the nerve, and propagated to its extremities." Now apply this language to the exaltation of temperature in any inanimate substance, however produced, and we may appreciate the merits of the chemical solution in the former instance.

"In some subjects of insanity," says Dr. Cox, of Fish Ponds, "who were under strong coercion in the horizontal position, with the head much elevated, whose face was red, and the vessels turgid, the difference of heat was very obvious, varying 10, 12, and even 15 degrees."

In apoplexy, the temperature has been known to rise, after death, a number of degrees above the natural standard; and its persistence has been found so uniform in apoplexy, that Dr. Cheyne regards it as a diagnostic symptom. The temperature of a lawyer, dead of apoplexy, was so high at twenty-four hours after death, that Portal delayed an examination of the body. The same phenomenon is observed after death from other diseases,—especially when the nervous system has been unusually concerned in the morbid process.

"In opening bodies at the Hôtel Dieu," says Bichat, "I have observed that the time in which they lost their animal heat was very variable; that a body continues warm a greater or less time, especially among those who have died suddenly of an acute affection, in the paroxysm of an ataxic fever, for example, or by a fall; for those who die of a chronic disease, lose almost immediately their caloric. The difference in the first is often three, four, or even six hours. This phenomenon arises from the fact, that whenever death is sudden, it interrupts only the great functions; the tonic action of the parts continues for a greater or less time after. Now this action disengages a little caloric from the blood that is in the general system." "When the disengagement of caloric has ceased in the body, that which remains in it becomes in equilibrium with that of the external air, according to the general laws of this equilibrium. Now these laws being uniform, their effect would be the same in every case."

Again, sometimes the temperature in apoplexy is greatly depressed

before death takes place; and this, too, while the circulation is such as to admit of blood-letting. Two cases of violent apoplexy ("violento paroxysmo") are recorded in the Ephemerides Germanii, in which the blood, as it flowed from the veins, was actually cold. Morgagni mentions an instance of another affection in which the blood flowed "in an icy cold stream" from the arm. Thackrah saw a similar phenomenon. So, also, De Haën. I need scarcely say, also, that when respiration is extremely labored and slow in apoplexy, the natural temperature is often either undiminished or considerably exalted. Our familiarity with the fact, however, only increases its importance, and shows, by the frequency of the coincidence, that respiration can be only remotely concerned with the generation of heat.

Here is another variety in apoplectic affections:

"While a gentleman," says Mr. Hunter, "who was seized with an apoplectic fit, lay insensible in bed, covered with blankets, I found that his whole body would, *in an instant*, become extremely cold in every part, continuing so for some time; and as suddenly would become extremely hot. While this was going on alternately, there was no sensible alteration in his pulse for several hours."

Here is another case, from the same observer, not less fatal to the theory of respiration:

"A man fell from his horse, and pitched on his head, and produced all the symptoms of a violent injury. There was concussion, and perhaps extravasation of blood. The pulse was at first 120, but came to 100, and sometimes to 90, and was strong, full, and rather hard. He was *very hot* in the skin, but *breathed remarkably* slow, only half the common frequency." Other injuries exalt the temperature in other modes of an equally vital nature. Thus, extirpation of the kidneys, through the increased stimulus of the blood, often raises the temperature of the body more than six degrees.

The following case, by Mr. Hunter, also, seems also to have been intended for our special purpose:

"February, 1781, a boy, about three years old, appeared not quite so well as common, being attacked with a kind of shortness of breathing in the night. It had become excessively oppressive about five o'clock on Sunday morning, so difficult that he appeared dying for want of breath. The common rate of breathing in such a boy is about thirty inspirations in a minute. At 10 o'clock, he was drawing his breath with a jerk,—about *two and a half inspirations*, or even less, in a minute. Pulse sixty, *faint*, slow. On tying up the arm, the vein did not appear to rise in the least, so that the *blood did not go its round.* Body *purplish*, especially the lips. He had a *fine warmth* on the skin *all over the body*, although in a room *without a fire*,—not covered with more clothes than common in the month of February, with snow falling at noon."—HUNTER.

This, and the preceding case, appear to differ in some physiological details. In the former, the disposition of the capillaries to generate heat seems to have been a good deal determined by the cerebral influence; in the latter, the alteration of the vital forces was probably owing to other causes. Like other cases, therefore, which I have recited, they serve, by their variety, to illustrate the vital nature of the principles which are mainly concerned in the production of animal heat. But, standing alone, they must either subvert the hypothesis

which concerns respiration, or we must have a chemical theory for the natural state of the body, and a vital one for its morbid conditions. This would be clearly absurd; at least, if there be any such thing as philosophy, or any consistency in the powers and functions of life. These examples show us, also, how very probable it is, that all our chemical hypotheses in relation to life are the mere offspring of habit, or imitation, or of narrow observation. It is certainly hard to give up the fruit of great toil and research; but it is harder for others to endure it, who prefer to be instructed by the voice of nature, rather than by artificial results.*

I shall present other examples to the foregoing effect, as supplied by morbid conditions of the system; since these, more than experiments, conduct us to the true philosophy of animal heat.

Every physician is familiar with the variations of temperature in disease; which, indeed, engage his attention in almost every case. It is often exalted when respiration is slow, and again depressed when breathing is hurried; and it is one of the most common phenomena to find it different, by many degrees, in different parts of the body, and under every variety of respiration and circulation. It will, therefore, be my purpose only to mention a few of the more unusual instances.

Dr. Philip has known the temperature of the skin at 74° Fh. in the cold stage of an intermittent, while in the hot stage it rose to 105°. Craigie found it at 107°, and 109°. Here the respiration and circulation are often most accelerated during the cold stage. This, with the vast difference in temperature, refers the depression of heat to other causes than the mere constriction of the capillaries in the cold stage. Here, too, as in all analogous cases, we have a coincident diminution of all other secretions. Piorry has seen the temperature in six cases of typhoid fever varying from 108° to 117°; and in one of these, the blood was at 113° Fh. In phthisis, he has known it at 114°, and in a case of pneumonia, the blood was 113°. Prevost found the temperature of the body at 110° in tetanus. Granville says it sometimes rises in the uterine system to 120° Fh., and that it depends on the degree of action in the organ. In hydrophobia, where respiration is probably always accelerated, Currie found that "there was no increase of animal heat in any one of five cases."

"The Reformer" says that, "*for a given amount of oxygen the heat produced is, in all cases, exactly the same;*" and that "*the consumption of oxygen in equal times may be expressed by the number of respirations*" (§ 440, no. 5; 441, *b*). But, in stating this, he did not reply to the following interrogatories propounded in my former Essay. Thus: How is the natural temperature maintained in consumption, where respiration is sometimes so greatly impaired as not to be compensated by any acceleration of its movements? Or why is it, when the lungs are impervious from condensation, and their function otherwise greatly impaired by destructive ulceration, the heat rises habitually in the afternoon, even to 114° Fh., and that, too, without any previous reduction of temperature, and often without any increase of respiration?

* I commend, also, to our minute philosophers Mr. Hunter's experiment upon the carp. It was partly intended to illustrate a vision of our author, by which, as he says, "like other schemers, he thought he should make his fortune." But our author had not only the good sense to abandon it, but the magnanimity to hold it up as a weakness of the human understanding.

Why do the palms of the hand "burn" when the rest of the surface is cool? Will chemistry explain? Will it explain, also, at the same time, the analogous phenomena, and the vicissitudes of heat and cold, the quick transitions from one to the other, that are forever perplexing the physician in his treatment of continued, remittent, and intermittent fevers? Will chemistry maintain, in conformity with its doctrine, that these periodical evolutions of heat are due to paroxysmal combustions of the tissues, especially where little remains to undergo the process, respiration obstructed, and yet a high exaltation of temperature? Explain, I say, all this in conformity with the "oxygen and fuel" system, and vitalism will surrender to the devices of human ingenuity.

Why is it, that when the general temperature of the body is at some 85° Fh., it may exist at the *scrobiculus cordis* at 106° and upward?* Mr. Malcolmson states, that in the Asiatic cholera, "the skin is sometimes *colder* during life than after death, and a partial rise of temperature over the trunk is *frequently* a fatal symptom." I have witnessed the same phenomena. Mr. M. also observes, that beriberi supplies analogous instances; and that when the temperature was extremely reduced, "it was not different when the limbs were closely wrapped in woolen, or when the thermometer was held between the soles of the feet or hands, and free evaporation carefully prevented." Is it not obvious, in these instances, that the power of generating heat was lost in consequence of modified vascular action; and if so, then the generation of heat depends upon vascular action, and is, of course, a vital product. This, too, is most emphatically shown, in the instances here and elsewhere stated, by the "partial rise of temperature over the trunk" just antecedently to death. It is analogous to those cases in which profuse perspiration breaks out in syncope, or as patients are in the act of expiring. It grows out of a powerful impression determined upon the *vires vitæ*, by which a sudden change of action is induced in the elaborating vessels.

Why is the temperature often exalted in congestions of the lungs, "where life is endangered by diminished communication with the air;" and why, in such a case, will "the abstraction of blood diminish the power of producing heat,"† although, by this means, we extend the communication of the lungs with the air? Or, again, in congestions of other organs, when the respiration is natural, the circulation in the lungs unobstructed, but the animal heat greatly reduced, why does it happen that the abstraction of blood will at once exalt the temperature, without affecting the respiration, or even increasing the force or frequency of the general circulation (§ 961, *d*)?

In the latter cases, the rationale appears to be, as I have endeavored to explain in my Essay on Blood-letting, that a direct change is exerted by the abstraction of blood upon the instruments of all vital actions, by which the calorific, as well as other functions, are improved or restored. It is here, animating these minute vessels, that we shall find the principles residing, by which we are to account for all the remarkable phenomena of animal heat. As the operation of these forces is modified, whether by natural or artificial causes, so will be the phenomena which depend upon them. This is universally true

* See my Letters on the Cholera Asphyxia, and other authors upon this disease.
† EDWARDS, on the Influence of Physical Agents on Life, p. 275.

of all the manifestations of the organic forces, whether they consist of vital phenomena, or of material products. The function of respiration is just as much concerned with one as with the other, and probably no more. It aids, like the chylopoietic viscera, in perfecting the great material from which bile, urine, the gastric juice, &c., are elaborated by the vital properties and their instruments. And just so is respiration concerned in the production of animal heat.

Again, "sympathy," says Bichat, "as we know, has the greatest influence upon heat. According as this or that part is affected, there is disengaged in others more or less of this fluid. How does all this happen? In this way: the affected organ acts sympathetically on the tonic forces of the part; these being raised, more caloric than usual is disengaged. It is precisely the same as in sympathetic secretions or exhalations. Whether the vital forces are raised by a stimulus directly applied, or by the sympathetic influence they receive, the effect that results from it is exactly the same."

And again, the same accurate philosopher: "Each system has its own degree of heat." This fact was not so well known in Bichat's time as now. But it was his induction from general principles. I shall only advert to the example of the dog's nose, which is familiar to all. Hunter, however, rendered the fact sufficiently obvious;—Davy and others have confirmed it. Now, how exactly all this corresponds with what is known of the vital endowments of particular organs. Where they are most strongly pronounced, there the temperature is apt to be highest, there the phenomena of organic life predominate, and there it is that morbific causes make their most frequent and deep impressions, and develop the most exalted temperature.—(See Essay on *Venous Congestion*, § 8, 9, *in Comm.*)

447, *e*. Finally, I come to what I consider an *experimentum crucis*, supplied by an able philosopher, and by one of the most able defenders of the chemical doctrine of animal heat. He states that great differences arise as to oxygen, during the respiration of atmospheric air:

"The real causes are chiefly certain inherent differences in the state of the venous blood, which are indicated, indeed, by other physiological facts, but by none *so unequivocally* as by this variety in the power of altering the oxygen of atmospheric air. The first cause is a difference in the degree of venosity or venalization of the blood in passing through the capillaries." The second and last "cause of diversity in the action of venous blood on atmospheric air is a difference in the proportion of coloring matter contained in the blood."

Now, if the chemical doctrine have any foundation, its advocates should show that there is a greater, or, at least, as great a consumption of oxygen in those states of the system which are attended by an exaltation of temperature, as in the natural condition of the body. On the contrary, however, they show just the reverse of this. Thus, the high authority whom I have just quoted:

"The inferior action of the blood on the oxygen of the air in its passage to the arterial state simply indicates, that it is less removed from a state of arterialization, that is, partakes less than usual of the characters of venous blood. Accordingly, the *least* alteration of oxygen *invariably* occurs in those *febrile* diseases where the *circulation is much excited, and the respiration at the same time free.* These conditions exist most especially in *acute rheumatism;* and it was, there-

fore, in cases of this disease that the four instances of *slight* action (on the air) formerly mentioned have occurred. On all these four occasions the blood was evidently more florid than usual, and in the instance where the *loss of oxygen was only* 0·57 of a cubic inch, the stream from the vein was so bright, that the gentleman who opened it had at first some suspicion that he had opened the artery."*

Here, also, we have, from a distinguished chemist, a philosophical resort to the modified condition of the system in disease, for an interpretation of the wonderful peculiarity of living organized matter in manifesting the power of generating heat.

447, *f.* We have thus again seen that the chemical hypotheses which immediately concern the functions of respiration are surrounded by too many exceptions to come within the pale of nature. These exceptions meet us every where in the habitual state of the animal, and in the history of disease they become almost as multiplied as the individual cases. Here it is, that we may most successfully contemplate the law and its operations, in the various modifications which it sustains from the influence of remote causes, and those within the body. Among the latter, are those of the mind, and the derangements to which the lungs are liable, both in their general and organic functions. But far more frequently, and more profoundly, is animal temperature directly exalted, or diminished, by affections of the stomach and of the nervous system. I need scarcely repeat, it would be absurd to have one theory to explain the phenomena of heat in health, and another in disease. It would be a violation of all philosophy, as well as a reckless disregard of all facts. According to the common designs of nature, there cannot be one law for the generation of heat in the healthy state of the body, and another which determines the exalted heat of fever and of local inflammations. While the various functions proceed in their natural manner, the evolution of heat, like the other products, remains without any radical alteration. But when the latter are disturbed in their natural character, the former is liable to corresponding variations, which can only be explained on the principle that the power of generating heat is as much an attribute of vitality, as any that may be concerned in the process of disease, and that their various modifications are constantly determined by analogous causes. It is a broad, fundamental principle, that "the general phenomena of the disengagement of heat remain always the same in animals with lungs, in those without them, and in plants, all of which have an independent temperature."

447, *g.* Some chemical philosophers, like the able Edwards, in treating of animal heat, have called to their aid the "*constitution*" of animals to explain certain anomalies which defy the chemical hypothesis. We hear much about the "power of the system to generate heat," without being let into the secret in what that constitution, and that power, consist. To allow that the forces of life have a large and uniform share in the generation of animal heat, would make a repulsive medley, in its connection with the chemical hypothesis. Now that "constitution," and that "power," are something more than ideal; something different from the organized structure; for, in the latter case, many variable phenomena, in adults, proceed from unvarying conditions of structure.

* Dr. Christison, in Edin. Med. and Surg. Journ., 1831, p. 101, 103.

Just so is it with all the varying conditions of animal heat. In health, the varieties are owing to peculiarities in the natural condition of the vital properties; in disease, they arise, like all the other changes, from morbid alterations of those properties; and, if the blood sustain any want of its proper influences from defect of respiration, this will contribute toward the modifications of temperature, in the same way that it affects the other results of life, and, I apprehend, in no other.

Although Dr. Edwards derives some illustrations regarding the connections of the phenomena of animal heat with respiration from certain morbid conditions of the body, as in asphyxia from carbonic acid, syncope, the cold stage of intermittents, &c., yet it is manifest that he looks upon disease as supplying facts which it is prudent not to investigate. "The question now is," he says, "what is the influence of the respiratory movements on the temperature of the body, when they are raised beyond the rate of health? We cannot answer this inquiry by observations on the sick. *The circumstances are then too complicated to admit of our deriving conclusions from them.*"—*Op. cit.*

In this conclusion I do not at all agree. It is an unwarrantable abandonment of nature for the contrivances of art. Morbid conditions, above all others, give us a clew to the true philosophy. The vital properties are altered by disease, and with them there is a change in all the phenomena and results, of which the modifications of animal heat are one. Hence, it appears to me, that a very obvious "conclusion" may be deduced.

447, *h*. In respect to the natural differences in constitution that are denoted by apparently contradictory facts in relation to animal heat, they are as clearly constituted by natural modifications of the same forces, which are as much, or more influenced by other causes than by respiration; whose power of evolving heat in young animals is greatly and rapidly depressed by the operation of cold, notwithstanding the respiration is accelerated during the first stages of the decline of temperature; but which, again, as the same animals advance in life, acquire the power of completely resisting the same cause without the former acceleration of the respiratory movements; "the animals thus passing from the state of cold-blooded to that of the warm-blooded," while in the hibernating mammalia, diminution of heat still goes on although respiration have come to a stand; or, when the cold becomes intense, is carried to its highest pitch by the very cause which had produced its great decline; which maintain an almost unaltered state of heat when the respiratory movements are greatly accelerated by external heat, and resist equally the heat of the surrounding medium; which actually abate the exalted heat of fever; which are so influenced by season, that their power of producing heat is said to be less when its production is greatest; which power "may be varied, in some, by suitable food and a graduated temperature;" which "is generally diminished in natural sleep, though modifications occur which change the relation;" which is so modified in the cholera asphyxia, that the temperature may greatly fail while respiration is accelerated, and the lungs free from congestion; or, is undiminished in asphyxia from carbonic acid, "when the respiratory movements are no longer seen;"* or may attain, as in apoplexy, preternatural vigor after respiration and circulation have entirely ceased.

* Portal says that the heat has been known to remain very high in these cases, as in apoplexy, for many hours after death.—*Sur l'Apop.*

"Constitution," then, and the "power of generating heat," manifestly relate to the vital properties, and to nothing else. The united operation of these powers, through their instruments of action, results in the elaboration of bile, gastric juice, heat, &c., from the blood. That particular determination by which they eliminate heat, in all parts of the body, may be called a law, though it is but the joint result of the vital powers, concurring in a certain manner to a specific effect. The result is variously affected by climate, season, the quality and quantity of food, stimulants and sedatives, cold or warm air applied externally or to the lungs, by morbific agents, and other causes; or, as the vital properties happen to sustain peculiarities in relation to individuals, age, &c., so will the generation of heat be modified when respiration is exactly the same; and along with those modifications of heat are variations, more or less coincident, of other products. The causes are obvious from the effects. The former are few and simple; the latter are diversified without end.

Most of the reasoning which abounds in authors who believe animal heat to depend specifically upon respiration, or the result of a chemical process, consists in reconciling difficulties by referring them to the vital powers, and sometimes to the entire exclusion of the chemical hypothesis. True, they do not say *vital powers.* They would otherwise be non-conformists. They speak of "constitution"—"the power of evolving heat,"—yet turn into ridicule the only true philosophy, and the only possible thing which they themselves can mean. If they hazard the "term *vitality*," it "is employed for the want of a better," but "without any connection with the mystification which sometimes attends its use;" while others, like Dr. Elliotson, can see nothing in "animal heat," "but a peculiar *state* only;" and here, as in the case of "vitality," Dr. E. "adopts the common language in speaking of animal heat," to make the subject intelligible.

It is from the blood, like all other animal products, that heat is derived. And since decarbonization, and, perhaps, an absorption of oxygen, is indispensable to the healthy performance of all other functions, it is doubtless important to the generation of heat; though manifestly less so in the latter instance, since we see the evolution of heat sometimes going on when respiration is nearly, or quite extinct; while in the cold-blooded animals it exerts but little, if any, influence upon temperature. Decarbonization of the blood, and probably the absorption of oxygen, are among the numerous processes by which its vivification is perfected, and by which it is prepared for an elaboration of the various animal products, and in animals of a certain constitution for the evolution of heat. When respiration ceases, all the most important functions immediately fail; but it is remarkable that the evolution of heat appears to be the *very last.*

I conclude, therefore, that the elaboration of animal heat, and all other secretions, are on a par in regard to principle. It is true, a certain proportion of latent heat may be extricated by the conversion of blood into the solid parts. But this would be counterbalanced by a corresponding change of the solids, particle for particle, into fluids. This appears to me to be fatal to a late doctrine which imputes animal heat to this cause; as well, also, to the condensation of gases. Besides, what becomes of the principle of condensation where the temperature rises after apparent death (§ 447, *d*)? Where is oxygen gas?

447½, *a*. In my former Essay I have also considered the hypothesis relative to the absorption of oxygen gas by venous blood, and the conditions under which it was supposed to unite with carbon, in the process of respiration. It only remains now to state circumstantially the views entertained by Liebig upon this subject.

1. "During the passage of the venous blood through the lungs, it absorbs oxygen from the atmosphere. Farther, for every volume of oxygen absorbed, an equal volume of carbonic acid is, in most cases, given out."

"The globules of venous blood experience a change of color, and this change depends on the action of oxygen."

"The red globules contain a *compound of iron;* and no other constituent of the body contains iron."

"The compound of iron in the blood has the characters of an oxydized compound." "No other metal can be compared with iron for the remarkable properties of its compounds."

2. Many "observations, taken together, lead to the opinion that the globules of arterial blood contain a compound of iron saturated with oxygen, which, in the living body, loses its oxygen during its passage through the capillaries."

The last quotation is a universal theory with our author. By it "the Reformer" interprets all motion, the generation of all power in the animal body, the circulation of the blood, inflammation and fever, obesity and emaciation, the various phenomena of life, and even death itself. "The oxygen of the air and the carriers of oxygen" are all in all. The "carriers lose their oxygen during their passage through the capillaries," when a "combustion of the tissues is set up," which is the true and only cause of the principle of life, of its extinction at death, and of all the unique phenomena of the animal creation (§ 350, nos. 3, 4, 5, 7, 8, 9, 10, 15, 18, 19, 46; § 440, nos 1 4, 5, 6, 8, 9, 10, 11, 12, 14, 16).

It is not, therefore, remarkable that "the Reformer" should have considered animal heat as life itself,—both the cause and effect of life (§ 441 *g*, 440, nos. 8, 9, 11, 12, 14, 16),—since every known process and result in the animal "machine" is due to "combustion."

3. "The compound, rich with oxygen (no. 2), passes, therefore, by the loss of oxygen, into one far less charged with that element.* One of the products of oxydation formed in this process is carbonic acid. The compound of iron in the venous blood possesses the property of combining with carbonic acid, and it is obvious that the globules of the arterial blood, after losing a part of their oxygen, will, *if they meet* with carbonic acid, combine with that substance (§ 440 *f*, no. 18, and *h*). When they reach the lungs, they will again take the oxygen they have lost; for every volume of oxygen absorbed, a corresponding volume of carbonic acid will be separated; and they will again acquire the power of giving off oxygen."

"In their return toward the heart, the globules which have lost their oxygen combine with carbonic acid, producing venous blood; and when they reach the lungs, *an exchange takes place between this carbonic acid and the oxygen of the atmosphere.*"

"The ORGANIC COMPOUND of *iron*, which exists in venous blood, recovers in the lungs the oxygen it had lost; and, in consequence of

this absorption of oxygen, the carbonic acid in combination with it is separated."

4. "Hence, in the animal organism, two processes of oxydation are going on; one in the lungs, the other in the capillaries. By means of the former, in spite of the degree of cooling, and of the increased evaporation which takes place there, the constant temperature of the lungs is kept up; while the heat of the rest of the body is supplied by the latter."—*Animal Chemistry* (§ 438, *b*, *c*).

447½, *b*. If, therefore, we exclude the vegetable kingdom as an important element in our interpretation of organic heat, we shall have seen by this fundamental hypothesis as to the globules of blood, that there can be no doubt that the general theory of animal heat has been founded upon certain speculations relative to a limited number of red-blooded animals, and often, as we have reason to suppose, to man alone. It takes no cognizance of all those white-blooded races that possess no ferruginous globules, and therefore no "carriers of oxygen gas," and whose temperature in some instances, as in the bee, approximates that of the human race (§ 444). However much a general theory may draw upon contingencies for its support, it must be universally applicable to the same combination of phenomena. It will not answer to have "ferruginous carriers of oxygen" for one class of animals, and something very different for another class, to explain what is common to both.

447, *c*. In the former Essay I have devoted to the questions relative to the elimination of carbon from the blood, and the formation of carbonic acid, all the attention which the subject might otherwise now require; and in another section of this work an argument is presented to sustain my former conclusions (§ 419). In the foregoing Essay I have endeavored to show that the distinguished chemical theorist, Dr. Edwards, is right in his position, that

"Carbonic acid is not formed at once, in the act of respiration, by the combination of the oxygen of the air with the carbon of the blood, but is entirely the product of *exhalation*."—EDWARDS.

I there urged, that the carbonic acid evolved from the chest does not exist in the state of that inorganic compound in the blood; but that the carbonaceous matter exists in intimate union with the blood, from which it is eliminated in the form of carbonic acid gas by the joint agency of the pulmonary mucous tissue and oxygen; the former taking the lead in the process (§ 419). The carbon of the blood is thus readily convertible into carbonic acid while undergoing that special vital process of the mucous tissue. I may quote from the Commentaries a remark which is not less extensively applicable in these Institutes. Thus:

"Before going farther, I may say, that, in having employed, as I shall continue to do, the established phraseology of chemical science, I have assigned many reasons in my first volume, as I shall others in my Essay on Digestion, for believing that every product of the animal system, including the *excrementitious*, is differently constituted in its elements from such as result from the agency of chemical forces; that, what we may find in our test glasses and crucibles has been really different before, or at the time of its elimination from the body. Chemical changes may accrue in excrementitious substances immediately after their elaboration; and the ultimate combination

may be uniform, especially where, as in carbonic acid, only two elements are ultimately concerned."—*Med. and Phys. Comm., ut cit.*

Although our author, while employed about the chemical rationale of organic products, speaks of them as though they were generated by the living organism as he is accustomed to observe them in the laboratory, and looks upon carbonic acid as equally the product of the organization as of the combustion of carbon (or, in his own language, "*the animal body acts in this respect as a furnace which we supply with fuel,*" § 440, no. 1), he now and then yields to the force of facts, and even allows, at one time, that the *iron* of the red globules exists in the state of an "organic compound" (no. 3, this section).

447½, *c.* It is also important to consider that the absorption of oxygen from the air, and the excretion of carbonaceous matter, take place through a highly organized tissue, and the moment life ceases, so also do these processes, notwithstanding artificial respiration. The same tissue, too, which performs those functions, secretes, also, a mucous fluid. This secretion being distinctly the result of vital action, it will hardly be insisted that the same tissue is simultaneously performing, in respect to another product, a mere chemical, or the physical functions of *endosmose* and *exdosmose* (§ 419). There is here the same incongruity as we have seen of the chemical theory of digestion, in establishing antagonizing processes for the conversion of food into chyme (§ 358, 360, 374).

447½, *f.* It remains now to notice, of the foregoing quotations (§ 447½ *a*, nos. 3 and 4), another of those extraordinary mistakes in fundamental principles, and where pure chemistry is concerned, which so much abound in our author's work on *Animal Chemistry.*

In the first place, we had been told again and again, that "animal heat is produced by the combination of oxygen with carbon or hydrogen," and in no other way (§ 440). That is the *combustion theory*, and without it there is no animal heat (§ 440, no. 6).

By referring, however, to § 447½ *a*, 2 and 3, it will be seen that oxygen does not unite with any combustible substance in the process of respiration, but only with an oxyd of iron; and that in no. 4, it is asserted that by this supposed union of oxygen with iron "*the constant temperature of the lungs is kept up*, in spite of the degree of cooling, and of the increased evaporation which takes place there." "*Hence,*" says Liebig, "*in the animal organism, two processes of oxydation are going on; one in the lungs* [the union of oxygen with an "*organic* compound of iron"], *the other in the capillaries* [the union of the absorbed oxygen with carbon, &c.]. *By means of the* FORMER, *in spite of the degree of cooling, and of the increased evaporation which takes place there, the constant temperature of the* LUNGS *is kept up; while the heat of the* REST OF THE BODY *is supplied by the* LATTER."—LIEBIG.

The general concurrence, even of chemists, in the foregoing exposition of the laws of animal heat, can alone justify any farther comment. But the work must be efficiently done to operate as a perpetual barrier to the pernicious invasions of chemistry.

I say, then, in whatever aspect the foregoing statement may be regarded, it is deeply discreditable even to chemical philosophy. In the first place, a distinct chemical provision is made for the "lungs" and for "the rest of the body," respectively, for the maintenance of

the same uniform temperature in all the parts, while it is assumed that the union of oxygen with the iron of the blood is exactly equivalent as a source of heat, and under all circumstances, to the union of oxygen with carbon and hydrogen in the process of combustion; without regarding the auxiliaries, "clothing," "laborious efforts," "cold water," &c., which are brought to the aid of the chemical process in "the rest of the body."

But that is not the worst of the doctrine; for it denies to the lungs any participation in that combustive process which is not only the foundation of animal heat "in the rest of the body," but of every result which appertains to life. Chemistry, of course, abandons the ground; but it must carry with it a mortification which is due from the physiologist (§ 350, *mottoes a, b; c, d, e*), and a farther recognition of the justice of the rebuke administered by Hunter (§ 350, no. 95).

It will have been seen, however, that the foregoing is only one of a constant succession of blunders whenever the chemist trespasses upon organic life. And were we to look yet farther into the last of the series, it would be found laden with objections. The physiologist, for example, has a right to insist that the general doctrine shall apply as well to the lungs as to the "rest of the body," and that there is an equal combustion of both. The chemist, therefore, necessarily places the temperature of the lungs at 196°, in making the union of oxygen with the iron of the blood equivalent to the combustive process. And having thus rectified the hypothesis, we find ourselves presented with a fundamental auxiliary to the general principle, that its integrity may be preserved in the lungs, which are beyond the reach of "clothing," while the surface of the body, which is more exposed to the operation of cold, is left to the general principle supported by the contingencies of dress, along with those other provisions, "food," "laborious efforts," "candles," &c., that are designed for the maintenance of the same temperature in "the rest of the body" which is accomplished by the two chemical processes in the lungs (§ 440, nos. 10, 11, 12, 13, 14).

While now adverting to the subject of carbonic acid in its supposed relation to animal heat, I will place in contrast two doctrines by our author, which make up a part of his system of pathology, as the best evidence I can offer, in parting forever with Organic Chemistry, of the sincerity of the motives which have governed the demonstrations I have endeavored to make in behalf of sound philosophy, the honor of my profession, and the best interests of man (§ 1 *b*, 350¼, 376¾ *b*, 820).

CHEMISTRY *as founded on the basis of "Experimental Philosophy."*	PHYSIOLOGY *as founded on the basis of "Experimental Philosophy."*
"We find, in point of fact, that the living blood *is never*, in any state, *saturated* with carbonic acid; that *it is capable of taking up an additional quantity*, without any apparent disturbance of the function of the globules. Thus, for example, after drinking effervescing wines, beer, or mineral wa-	"If we consider the fatal accidents which so frequently occur in wine countries from the drinking of what is called feather-wine, we can no longer doubt that *gases of every kind*, whether soluble or insoluble in water, possess the property of *permeating animal tissues, as water permeates unsized paper.*

ters, more carbonic acid must necessarily be expired than at other times. Less, however, will be given out after the use of vat and still wines, than after Champagne."—LIEBIG'S *Animal Chemistry.*

This poisonous wine is wine still in a state of fermentation, which is increased by the heat of the stomach. The *carbonic acid gas* which is disengaged, *penetrates through the parietes of the stomach, through the diaphragm, and through all the intervening membranes, into the air-cells of the lungs, out of which it displaces the atmospheric air.*"—LIEBIG'S *Animal Chemistry* (§ 350, nos. 24, 43).

448, *a.* The main objection to the vital doctrine of animal heat, or that which places it on the common ground of secreted products, seems to have arisen from a difficulty of comprehending the manner in which heat can be generated by any process than such as has been most familiar to the senses. The objectors, however, have no difficulty in assuming that the "nervous power governs the chemical forces in the formation of animal heat." This admission of the instrumentality of the nervous power is founded upon certain irresistible facts which chemistry cannot appropriate, and goes very far in allowing the force of analogy which refers the production of animal heat to the same great principles of life that are known to preside over all other products of animated beings.

448, *b.* But, is there any stability to the doctrines which relate to the evolution of caloric in the inanimate world? None at all. Even Lavoisier's hypothesis is overthrown.

"A new theory is, therefore," says Turner, "required to account for the chemical production of heat. But, it is easier to perceive the fallacies of one doctrine, than to substitute another which shall be faultless, and it appears to me that chemists must, for the present, *be satisfied with the simple statement*, that *energetic chemical action does, of itself, give rise to increase of temperature.*"—TURNER'S *Chemistry.*

448, *c.* Let us now borrow from the same distinguished chemist, an example by which the foregoing statement is sustained, and which will remove all difficulty as to the problem that animal and vegetable heat are elaborated by the organic force through the instruments of vital action, according to the other products of organic beings. Facts will receive their proper interpretation, an important analogical induction will remain inviolate, while the uniformity of other secreted products, coinciding with the uniformity of temperature, or each varying together under the same vital influences, expounds the latter phenomenon and corroborates the vital interpretation. Thus, Turner:

"It is a well-known fact, that *increase* of temperature frequently attends chemical action, though *the products contain much more insensible heat than the substances from which they were formed.* This happens remarkably in the explosion of gunpowder, which is attended by intense heat; and yet its materials, in passing from the solid to the gaseous state, expand to at least 250 their volume, and consequently render latent a large quantity of heat."—TURNER.

448, *d.* Now, although it be allowed that phenomena of the foregoing nature may have been explained by supposed differences be-

tween specific and latent heat, they show us that heat exists, and is developed, under different conditions; and to expound the variety of results in the mineral world, it has been necessary to multiply yet farther the natural states of caloric (§ 448, *e*).

448, *e.* As showing farther, also (*c*), that there is some obscurity attending the phenomena of ordinary combustion, I may quote the high authority, Dr. Kane, to that effect, who says, that,

"Laying aside altogether the attempt at deducing the phenomena of combustion from any change in the amount of latent or specific heat in the bodies which enter into combination, it remains only to be admitted as a general and independent principle, that chemical combination is a source of heat and light. It is, however, impossible to arrest inquiry at that point; and, accordingly, the *speculations* of philosophers have been directed, in seeking a cause for the phenomena of combustion, to the disengagement of electricity," &c.—KANE'S *Elements of Chemistry*, 1841.

448, *f.* Now, however it may be that the results are the same in the inorganic world, upon the theories either of caloric or electricity, the remarkable differences in views in that respect show the difficulties which chemistry must encounter when it approaches the philosophy of organic heat; and this, especially, when we consider the vital nature of the development of electricity and light in living animals. —(See *Medical and Physiological Commentaries*, vol. i., p. 107–119.)

The physiologist undertakes no explanation of the *modus* in which organic heat is elaborated. He avoids all inquiries of that nature, although he might proceed to interrogate the manner in which the vital principle operates with as much propriety as the chemist "speculates upon the cause of the phenomena of combustion." But, in doing this, he would trespass upon inscrutable difficulties, and encumber philosophy with useless hypotheses.

8. GENERATION.

449, *a.* The eighth and last great function common to animals and plants is generation. This function, being alone designed for the perpetuation of the species, is not necessary to organic life. It is here, however, in all the processes that are connected with the formation of the germ, and of semen, in the preparation of the generative organs for impregnation, in the moral and physical circumstances attending the act of copulation, in the impregnation of the ovum, in the development and growth of the fœtus, in the sympathetic influences of the uterus upon the mammæ which result in the formation of milk, and in all their individual and connected designs, and in their great final cause of perpetuating the species, and in the various incidental provisions which are supplied for the fulfillment of that end, that chemistry and physics may be as effectually banished from physiology, as by the demonstrations which I have made in relation to the germ, or by those which respect digestion, or organic heat, or the nervous power.

449, *b.* What may be the extent in which the male participates in producing the offspring, it is impossible to know; probably as impossible as a knowledge of Creative Energy. We know, however, that the male and the female impress, alike, their own moral, vital, and physical character upon it. But the mother supplies the germ, also.

449, *c*. In another work I have examined the merits of the old doctrines of seminal animalcula, and their germinal character; lately revived along with other illusions or pretensions of the microscope. The subject is scarcely worthy a renewed discussion (§ 131).

449, *d*. It may be finally said, that whatever is true of the essential physiology of generation, as it relates to animals, is equally so of plants. The coincidences, too, which are so striking in this function of the two organic kingdoms, remove every ambiguity which has been supposed to attend the more important functions of plants, confirm the vital character of the whole, and, with the universal analogies, refer the whole to the same properties of life which carry on the organic functions of the animal kingdom. It were impossible, according to the ways of nature, that a function, like generation, which depends in animals upon a vital condition of all other processes, and which is a great final cause of all those processes, should, in plants, depend on others of a different nature. By the coincidences, therefore, in the function of generation between animals and plants, I prove a like coincidence in the vital character of all the organic functions of both animated kingdoms (§ 185).

But little can be said relative to the function of generation, beyond certain important relations that have been considered, that can serve as a ground for Institutes in Medicine (§ 63–81). Its more extended consideration belongs to elementary works on physiology.

II. PECULIAR, OR ANIMAL FUNCTIONS.

A. *Functions of Relation.*

1. SENSATION.

450, *a*. Having distinguished three kinds or principal modifications of sensibility, namely, *common*, *specific*, and *sympathetic*, and as sensation is performed through that property, there are naturally three modifications of the function; to wit, common sensation, specific sensation, and sympathetic sensation (§ 194–204).

450, *b*. The nerves are the organs of the functions, and the nervous centres the recipients of the transmitted impressions. But, it is important to remark, that the parts most essential to sensation are the extremities of the nerves at their origin and termination, and that the trunks are, mainly, the conductors. This is also true of voluntary motion, and of those involuntary movements that are excited by the nervous power. The nerves of the organic viscera, therefore, follow this rule, as it respects all natural, morbific, and remedial agents. A neglect of this consideration has led to fallacious conclusions in medicine from experiments on the trunks of nerves (§ 110–117, 826 *d*).

450, *c*. Common and specific sensation require a continuity of the nerves with the brain, and a co-operation of the mental power, perception. Sympathetic sensation may be excited in the brain, or spinal cord, or certain parts of the ganglionic system, either in their connected state, or when disconnected. In their most natural condition, it is probable that all the parts concur more or less together in giving rise to sympathetic sensation; though some parts more than others, according to the nature of the impressions transmitted and the part from which they are transmitted (§ 201).

450, *d*. Common sensation appertains to all parts, and is the cause of pain. In the natural state of the body it is inappreciable, but may be greatly roused by injuries and by disease. Its intensity will then depend upon the nature of the part and the exciting cause. It is apt to be most exquisite in parts where specific sensation is least; as in tendons, ligaments, membranous tissues, &c. (§ 198).

450, *e*. Specific sensation corresponds with specific sensibility. It is the function through which we acquire a knowledge of external things, and is, therefore, the great inlet of knowledge. It has, of course, the several modifications which appertain to specific sensibility (§ 199, 200); consisting, indeed, of five apparently different functions. The expanded nerves of sense, which are the organs of this function, it is superfluous to say, are supplied with auxiliary means, such as the various appendages to the retina, to the auditory nerve, &c. A close analogy exists among the whole, and they may be brought more or less to the aid of each other. Although a common function, its remarkable modifications are shown by their uses, respectively, and by the necessity of certain specific stimuli to each. As with common sensation, the specific kind requires the aid of perception. The *rationale* of the entire function is far more wonderful and incomprehensible than that of sympathetic sensation and its various results which terminate in the influence of the nervous power on organic actions, and for which the grossest doctrines in chemistry and physics have been substituted, because the vital interpretation is "inconceivable," or cannot be subjected to the critical inspection of that far more obscure, but acknowledged, causation in the chain of perception, specific sensation (§ 222–237). What can task the understanding more than the step in the process of intellection as connected with the functions of sense; beginning with light and its properties, or with the odor which none but the dog can discern, or the abstractions that convey to the mind all the varieties in taste, or the modified undulations of air which render so distinct from each other all the gradations of sound, from the Æolian harp to the braying of a jackass; the impressions of each upon the extremities of the nerves of sense, one alone upon the eye, another alone upon the nose, and another upon the ear alone; the transmission of these impressions along the trunks of the nerves to their other extremities in the brain, but in either of which no such impressions can be originally excited; their excitement of the brain and the co-operation of the mind, by which the nature of the primary impression is discerned, and the external objects realized by the inward immaterial agent according to their real material existence (§ 188½, *d*, 500, *n*)?

450, *f*. The common hypotheses which have been propounded to explain specific sensation, such as the motion of a nervous fluid, galvanism, vibration of the nerves, the passage of light, of undulations of air, &c., to the brain, betray a general disposition to avoid the phenomena of life for those which are manifested by inanimate objects. But, of this I have already had enough (§ 189, 234–237).

451, *a*. The action of material objects upon the mind through the function of sensation, and the astonishing influences of mental emotions upon irritability (§ 188, *a*), and of the will upon the voluntary muscles (§ 227, 1st, 233), bring the laws of organization and those of the immaterial mind and instinct into harmonious relation; while the

nature of mind and the impressions it receives illustrate the character of the vital properties (§ 450 *e*, and *Medical and Physiological Commentaries*, vol. i., p. 92–102).

451, *b*. Impressions upon the brain through the medium of specific sensation leave no transcript; and perception of objects without sensation, as in reveries and dreams, has led to a denial of the materiality of the world; supported, too, by far greater ingenuity than those objections to a vital principle which are regardless of all its unique phenomena.

451, *c*. It has been seen that perception is necessary to sensation, in the usual acceptation of this function, which is essentially mental. This term, however, is employed to represent the cerebro-spinal impressions which give rise to involuntary motions, whether in animal or organic life; and "feeling" is used by Mr. Hunter, and others, to denote the susceptibility of organs to the existing condition of each other, by which their concerted action is maintained through the medium of the nervous system. It is obvious, however, that the mind takes no cognizance of those impressions which result in involuntary motions; no perception, no act of the will, is excited, so far as it respects the direct results. And, although there be an analogy between all the influences of sensation in animal life, it reaches least to the movements which spring from the nervous system in organic life, since the impressions made upon the brain through specific sensation never affect the organic actions; while there is a perfect identity of effect between those impressions which give rise to involuntary movements in animal and organic life.

451, *d*. As the term sensation, therefore, has a very different import in the different cases; and as in one the transmitted impressions terminate in exciting an act of the mind, while in the other no such act is called into operation; but differently, also, from the former case, the nervous power is excited in the nervous centres and then determined with the effect of a vital agent upon all other parts (§ 226); and since, also, the impressions through specific sensation must be exerted upon the brain, while in the latter case the results may be equally pronounced whether the impressions be made exclusively upon the brain or on the spinal cord (§ 473 *c*, no. 5), I have made a third distinction in sensibility to separate its office in the function of sympathy from its province as described under the varieties of common and specific sensibility, and to avoid the confusion which has hitherto prevailed by an indiscriminate use of the term *sensation* (§ 194, 199½, 201, 204, 453, 523).

451, *e*. This third distinction in sensibility, I have called sympathetic sensibility (§ 201); and this conducts me to a third distinction in the corresponding function, and which should be known by the same epithet (§ 464–467, 473 *c*, no. 5, 474, no. 4).

The epithet *sympathetic* denotes the special function of sympathetic sensation, which has been sufficiently described in the preceding section, and in what has been said of sympathetic sensibility (§ 201–204).

451, *f*. The considerations made in § 450, *e*, illustrate the vital philosophy of sympathetic sensation as one of the functions concerned in the transmission of impressions from one part to another through the medium of the nervous centres, and in which the nervous power is the agent by which the reflected impressions are exerted (§ 222, &c.).

The facts in the former case bear with the strongest force of analogy in demonstrating the entire absence of all chemical agencies in the phenomena of the nervous power. The alliance of the whole, throughout the moral and physical results of specific sensation, place the whole upon common ground in respect to principle ; and if it be true that nervous agency in one case is chemical, it is equally so in all, and equally so with perception itself (§ 188½, *d*). Other demonstrations to the same effect will be presented in another section (§ 500, *n*).

2. SYMPATHY.

452, *a*. I now enter upon the consideration of a function which belongs not only to animal life, but has far greater and more important relations to the organic life of animals. Although it have no existence in the vegetable kingdom, where its anatomical medium is also wanting, it does not bestow those striking distinctions in the organic life of the two animated departments of nature which the importance of the function, and the presence of the nervous system, in the animal economy, would denote. The organic actions are essentially alike in both, conducted in both by common properties appertaining to the various tissues and organs, and only influenced through the function of sympathy in animals (§ 185).

452, *b*. Nevertheless, it is a function of wonderful characteristics, and can only be appreciated by an extensive investigation of its endless variety of phenomena. And yet is this function extensively ridiculed by enlightened men ; and even Müller, who has written more luminously upon its laws than any other observer, applies them only in certain natural processes, considers the nervous power the actual cause of motion, construes the function of absorption according to the physical rationale, defends the hypothesis of endosmose and exdosmose *in extenso*, interprets all the secreted products upon chemical principles, expounds diseases by the humoral pathology, and recognizes no therapeutical influences of medicine but through its absorption into the circulation. For all this he was well commended by the British and Foreign Medical Review, while the same critical survey of that remarkable work on Physiology stamped its displeasure upon those doctrines of life which render the work a proud monument of the age.

Again, no one has employed his knowledge of the laws of sympathy more usefully than Bichat. "The word," he says, "is of but little consequence, provided what it expresses is understood." And yet, while he also affirms that "we know the principle exists," he also says, that the "word is only a veil for our ignorance in respect to the relations of the organs to each other" (§ 234).

452, *c*. Sympathy is the most important function which is peculiar to animals ; since upon it depend, very greatly, the right performance of the organic functions, and a vast range of pathological conditions, and the greatest amount of therapeutical influences. It also overthrows the venerable doctrines in humoralism, in all their contemplations of vitiated blood, morbid lentor, "living putrefaction," and of those conformable therapeutical means which were invented under the significant names of incisives, deobstruents, inviscants, incrassants, diluents, attenuants, astringents, relaxants, refrigerants, &c.

453. Sympathy has been commonly reputed as one of the properties peculiar to animals; but it is not only a function, but one of great

complexity, since it involves the united operation of sensibility and the nervous power. The result of that concerted action is sympathy, in its proper acceptation. All other functions correspond, respectively, with individual properties, as sensation with sensibility, motion with mobility, &c., though the various properties may be necessarily instrumental to each other.

In the farther prosecution of this subject, I shall consider,

I. The general uses of the nervous systems.
II. The different orders of nerves (§ 462, &c.).
III. Experiments to determine the Laws of the Vital Functions (§ 476, &c.).
IV. The varieties or kinds of sympathy (§ 495, &c.).
V. The laws of sympathy, and their application to pathology and therapeutics (§ 512, &c.).

I. OF THE GENERAL USES OF THE NERVOUS SYSTEMS.

454, *a*. The phenomena of the nervous systems (the cerebro-spinal and ganglionic), in their connection with organic processes, forcibly declare how broad is the gulf between the properties and laws of dead and living beings, and how vast, magnificent, and profound is the science of life in its varied aspects of health and disease.

454, *b*. The nervous system having no existence in plants, has given rise to the fundamental distinction of "animal and organic life" (§ 96–123).

454, *c*. The cerebro-spinal system appertains particularly to the organs of animal life, though it contributes largely to the organic viscera (§ 111–117).

The ganglionic system is universally appropriated to the organs of organic life, and pervades every part of the animal; since organic actions are carried on as well in the organs of animal life, as in the organic viscera (§ 115).

455, *a*. The great final cause of the brain is to subserve the intellectual powers in man, and instinct in the lower animals (§ 241, 454 *b*, 500 *p*). But, reason and instinct would avail but little, were their operations circumscribed by the limits of their organ. Hence the brain is prolonged into nerves, and various connections are thus established with all parts of the body, and with the external world. Admirable as is this Design of associating in harmonious action the immaterial with the material parts, it would still be defective, and the economy of nature obviously violated, were not an organ so prominent in the animal mechanism rendered subservient to the great purposes on which its existence depends. Therefore that other system, the ganglionic, has been established, with intimate connections with the cerebro-spinal; while the brain itself contributes nerves directly to the most important of the organic viscera. The principal relations to the great final cause of the brain are determined by direct prolongations of the organ to the different parts of animal life; but those which are more especially designed to answer its secondary uses belong to the ganglionic system, which binds together, in harmonious action, every part of the complex organization, and influences the organic functions of every part (§ 129, 523).

455, *b*. It appears, therefore, that one of the great secondary uses of the cerebral system is that of co-operating with the ganglionic in

establishing a circle of sympathies among the organs of organic life, and preserving the whole in that harmony of action that is indispensable to the life of complex animals.

455, *c*. Thus we learn that the various parts of the organic mechanism of animals are not only indispensable to each other, but that a certain established influence of one upon the other is necessary to each, and that the functions of the whole may be fatally deranged, either directly, by causes that may interrupt the common chain by which the relations are established, or indirectly, as by a blow on the stomach, or by poisons acting upon some part of the intestinal mucous tissue, or by withdrawing some particular organ from the symmetrical whole (§ 109, 129).

455, *d*. Whatever, indeed, may affect the powers and embarrass the functions of the cerebro-spinal system, will more or less disturb this concert of action, may modify the functions of every part, and may derange the whole series of vital phenomena. The nature of the disturbances will depend entirely upon the nature of the impressions produced upon the nervous systems, as well as upon the rapidity and violence with which the impressions are made. Direct injuries do it in one way, and according to their nature and extent. Morbific, or other causes, acting upon other parts, affect the nervous centres, and consequently give rise to remote derangements, in other ways, according to their nature, and the violence with which they operate. Medicines do the same thing, and according to their nature, their dose, and according to the nature of the part, as well as the existing state of the part to which they are applied, or that of other parts upon which they may act sympathetically. New circles of sympathy, however, in all these cases, are liable to spring up, and that, too, in rapid succession (§ 222–233¾, &c.).

455, *e*. The same laws, precisely, are concerned throughout. We do not, however, witness the same demonstrations of sympathy in health as in disease, or as when remedial agents operate; since, in the natural state of the body, the nervous influence is more or less *in equilibrio;* operating uniformly and equally on all the organic viscera, and thus maintaining among them one concerted, harmonious action. But this power being constituted with the greatest sensitiveness to the various conditions of all parts, that it may transmit the existing condition of each one to the whole (as strikingly seen in the almost instant interchange of function between the kidneys and skin, on the contact of cold air, &c., § 422), it necessarily happens that when the state of any one part is varied from its natural standard, that part will transmit an unnatural influence to the brain and spinal cord, will develop the nervous power in an unnatural manner, and thus produce disturbances in other parts (§ 350, no. 19). The alterative influences, therefore, of morbific and remedial agents necessarily result from the natural physiological laws of the nervous power in connection with the instability of the organic properties, nor can it be otherwise. The principle is absolutely ingrafted upon the constitution of animals.

455, *f*. I say, therefore, that when unusual causes operate, whether upon the nervous centres or upon remote parts, they necessarily develop the nervous power in greater intensity than it exists in health; when it is reflected abroad upon various organs, and with the greatest variety of effect. The parts upon which it may fall will depend upon

their existing susceptibility and the nature of the remote causes; and the nature of the effects produced will depend greatly upon the particular virtues of the morbific or remedial agents; for it is also an important law that the nervous power itself will be altered according to the particular nature of the impression which may be produced upon the part on which the agent may exert its direct effect (§ 222, &c.).

455, *g*. The actions which are thus influenced through the connecting medium of the nerves are not alone the great general functions of organs, such as digestion, the action of the heart, &c., but, also, those of their minute constitutional organization. Here it is, indeed, that morbific and remedial agents exert their principal effects (§ 483, &c.).

456, *a*. In the ordinary rhythm of the organic system, however, the capillary and extreme vessels are not as dependent on the nervous influence for the precision of their functions, as the complex organs (§ 455, *e*). It is greatly with these vessels as with the analogous ones in plants. They have an independent function in each particular part, in the performance of which no assistance is wanted from each other or from other organs (§ 383, 394). And this leads us to observe the reason of the absence of a nervous system in plants, while it is more or less necessary to animals. The vessels go up continuously from the roots to the leaves, and continuously back again, and there are only vessels; no complex organs. Each part of a plant has within itself an organization adequate, or nearly so, to its independent existence. It is otherwise, however, with animals. Here, other essential parts are superadded to the simpler mechanism, are made dependent on each other, and a certain correspondence of action rendered necessary to the integrity of the whole. For the fulfillment of these ends the nervous system is also superadded, with its wonderful attribute, the nervous power, that a perpetual change of influences shall be maintained among the great organic viscera (§ 222–233). But not so with the capillary vessels, since the functions of these may go on independently of the nerves, nor is a consent or correspondence of action among them at all necessary (§ 257, 233).

456, *b*. Slight influences, however, upon the nervous centres will determine the nervous power, with a very manifest effect, upon the capillary and extreme vessels, as seen in blushing, and in the experiments by Philip (§ 227, 477, &c.); and coming to the ordinary operation of disease, and of morbific and remedial agents, we have constant demonstrations of the great susceptibility of these vessels to the action of the nervous power, and of strong reciprocal sympathies among them (§ 394).

457. One of the most striking peculiarities of the ganglionic system is that of its not transmitting the influences of the will to the organs which it supplies, notwithstanding it is so intimately combined with the cerebro-spinal nerves; while, on the other hand, the passions operate more powerfully through the ganglionic than through the cerebro-spinal nerves (§ 476 *c*, 500 *e*).

This fact shows us, at once, that the sympathetic system must have certain special functions; and when we trace out its anatomical constitution, and its distribution to the essential parts of organic life, we perceive that its special office must be that of maintaining a harmony of actions among these parts; and experimental observation confirms this induction. Nevertheless, from the exquisitely delicate nature of

this high office the nerve is rendered intensely susceptible, and from the intimate manner in which it pervades the organic tissues, it is made to exercise a certain, but scarcely appreciable, influence upon their organic actions (§ 456, *b*).

458. The relations of the cerebro-spinal and ganglionic systems to each other, their special or mutual functions, and those of individual nerves, all having their distinct individuality, yet all more or less related and concurring in harmony, and for important purposes in animal and organic life, supply the most complex and astonishing instances of Design to be found in nature; and their natural attributes, existing under the most absolute laws, afford a ready interpretation of the endless phenomena of remote sympathy, as the result of disease, or of morbific or remedial agents.

459, *a*. All parts of the nervous centres are not only more or less mutually connected in function, but all parts of the nervous system are subordinate to the brain. There are no distinct, separate, and independent influences, of an involuntary nature, exerted by any parts of the nervous systems in their state of integrity. They all concur more or less together. This is experimentally demonstrable, as well as denoted by the natural phenomena. If, therefore, it should appear from experiments upon the spinal cord, for example, while connected with the brain, through any remaining communications, that the influences are determined by the cord alone, we may be assured that the brain has participated (§ 201, 473, 481, Exp. 15).

459, *b*. I have said in my Essay on Bloodletting (in Med. and Phys. Comm.), that the injuries which are inflicted on the spinal cord, to determine the specific functions which have been assigned to it, are so severely propagated to the brain, and may so affect the properties of that organ, that the results which appear to flow from the spinal cord may be actually due to the cerebral influence, or to an interruption of that influence when the spinal cord is divided or destroyed. Both principles, in the latter case, may act in co-operation; the cerebral influence being determined through the superior nerves and the ganglionic system, and otherwise impressed by a reflected influence from below that part of the spinal cord, where its direct connection with the brain is interrupted (§ 480, *c*, *f*).

While, therefore, the brain remains, experiments upon the spinal cord are entitled to much less confidence than those which are made upon the brain. But even when the brain is removed, the vital properties of all parts become so profoundly modified in consequence, that we can scarcely infer with accuracy the specific functions of the spinal cord from subsequent experiments (§ 476, *c*).

459, *c*. The late experiments by Dr. Stilling, with strychnia applied to the spinal cord, are entirely consistent in their results with the foregoing remarks (*b*). From these experiments he supposes that the spinal cord is greatly independent of the brain, and that when divided in numerous places, each portion is capable of the same influences upon the parts it may supply, as when the whole cord is in its natural state. Thus, when the small portion connected with the fore-legs is separated from the rest of the cord by two incisions, and strychnia is applied to this isolated part, the legs will be convulsed. Still, however, there are remaining and important communications of this apparently isolated part with the head, and with all other parts of the

spinal cord, which will forever embarrass these critical inquiries, unless there be a removal of the brain (§ 473 *a*, no. 2, 473 *c*, 494 *d*, 514 *e*).

459, *d*. "The experiments of M. Le Gallois," says Wilson Philip, "prove, in the most satisfactory manner, that a principal function of the spinal marrow is to *excite* the muscles of voluntary motion, and that it can perform this office independently of the brain, as after the removal of the brain. Yet we constantly see injuries of the brain impairing the functions of the spinal marrow. Of this apparent inconsistency, M. Le Gallois justly remarks, that two facts, well ascertained, however inconsistent they may seem, do not overturn each other, but only prove the imperfection of our knowledge."

Now, in the foregoing case, there is no difficulty in reconciling the facts by the interpretation which I have given to the action of the will and of the nervous power. The will operates as an exciting cause to the nervous power, which then determines voluntary motion. But, the motions are never voluntary after the removal of the brain; but the nervous power pervades the whole system of motor nerves, and when stimuli are applied to the spinal cord after removing the brain, the nervous power becomes an exciting cause of involuntary motions (§ 226, 473, 500).

459, *e*. Every principal part of the nervous system has a certain special office which is exercised in conjunction with the whole. "The cerebrum does not act like the cerebellum, nor the cerebellum like the medulla oblongata, nor the medulla oblongata like the spinal cord and nerves. In the cerebral lobes resides the faculty by which the animal thinks, wills, recollects, judges, becomes conscious of sensations, and commands its movements. From the cerebellum is derived the faculty which co-ordinates the movements of locomotion; from the tubercula bigemina or quadrigemina, the primordial principle of the action of the optic nerve and retina; from the medulla oblongata, the motor or exciting principle of the respiratory movements; and, lastly, from the spinal cord, itself, the faculty of blending or associating into combined movements the partial contractions immediately excited by the nerves in the muscles of animal life."

459, *f*. Enough, however, is known to show us, that when the cerebro-spinal and sympathetic systems exist as a whole and unimpaired, they act more or less as a whole; but that different parts have certain peculiarities of function, and that when injuries befall any part of these great systems, a portion of the whole may perform certain circumscribed functions, at least for a limited time, and often, perhaps, as perfectly as the whole apparatus in its state of integrity (§ 201, 515 *a*, 516 *d*, no. 8).

Impressions, as I have said, when transmitted through sympathetic sensibility, may be received either by the brain, spinal cord, or certain parts of the ganglionic system; and either connectedly or independently. But, in the natural state of the nervous system, all such impressions, when received especially by an individual part, are doubtless propagated to the other parts, and institute that harmonious concurrence in all the parts which renders the whole nervous system instrumental in determining the ultimate phenomena. This is even true of so local a phenomenon as the contraction of the sphincter muscles, however that contraction may be maintained after destruction of the brain and of the superior parts of the spinal cord (§ 461½, *a*). These

conclusions are warranted in experiment, and by all that is known of the dependence of the harmonious relations of organs upon the presiding influence of the nervous system. There must be harmony there as a fundamental requisite (§ 129).

459, *g*. In the application which I have made of the nervous power, in the present and in my former works, to the theory of disease and to the modus operandi of remedial agents, it is important to regard the whole nervous system in its unimpaired relations to its own and to other parts.

460. No experiments upon the sympathetic nerve can show that it has any fundamental agency in the organic processes; for the moment any unusual impressions are made upon it, the nervous influence is unnaturally excited, and determined with more or less violence upon the organic properties, and thus deranges the functions.

461. It is an assumption to say that the nerves have any generating effect upon the secreted products, however probable it may be that they influence the organic processes and their results. If the products are altered by impressions made upon the brain or nerves, it is because the nervous influence is preternaturally determined, as a morbific agent, upon the organic viscera, or because the influence is withdrawn, or a violence done by interrupting the relation of parts; as when the pneumogastric nerve is divided. Such division of nerves may have all the effect of a morbific agent, producing congestion and inflammation; the very division of the nerve determining a shock of the nervous power upon the organic properties of the part to which the nerve is distributed. But, in the instance of dividing the pneumogastric nerve, the gastric juice, and the pulmonary mucus, are secreted in preternatural abundance. Digestion, however, becomes at once greatly impaired; but even that may be more or less restored by rousing the nervous influence in the divided portion of nerve leading to the stomach, by means of galvanism, or other irritants applied to the nerve (§ 446 *c*, 473 *a*, no. 2, 473 *c*).

461½, *a*. The brain and spinal cord are not necessary to the organic life of the fœtus, not even to the action of the sphincter muscles; since both have been wanting in the full-grown human fœtus (§ 459, *f*). It is possible, as supposed in Dr. Clark's case, that even the sympathetic nerve may be absent; organic life being carried on in the fœtus mainly by the simple vessels of nutrition, and without any action, concerted or otherwise, of the great organic viscera (§ 109 *b*, 264). No concerted action is necessary. The principal organs carry on alone the vegetative process. This, therefore, is a negative demonstration of the final cause of the nervous system, and co-operates with its absence in plants in demonstrating the essential independence of organic life, in animals, of the nervous influence.

461½, *b*. The functions of the sympathetic nerve are, to a certain extent, independent of the brain and spinal cord, and the relations of the latter to the former become most important after independent life begins.

461½, *c*. Nevertheless, the influences of the cerebro-spinal and sympathetic systems are more or less reciprocal in organic life. And, although sympathies may be combined by the ganglia of the sympathetic nerve, as in contiguous sympathy (§ 497), this nerve transmits the impressions it receives to the brain and spinal cord in the same

way as the cerebral and spinal nerves, and influences are propagated from the cerebro-spinal axis upon either system of nerves, and the organs they supply, in a like manner.

II. OF THE DIFFERENT ORDERS OF NERVES.

462. Corresponding with the two important functions of the brain and spinal cord, those of receiving impressions from external objects, and of generating the nervous power, are two orders of nerves; whose distinct characteristics were first pointed out by Sir Charles Bell. It is the office of one of these orders of nerves to transmit the impressions to the nervous centres, and of the other to serve as a medium for the exercise of the nervous power upon all parts of the body. This combined function establishes the more complex one of sympathy.

463, *a*. The foregoing anatomical discovery only establishes what was before known of the laws of sympathy by accurate observers of nature. The general attributes of sympathy were understood by Hippocrates, and were at the foundation of no small part of his medical philosophy and practical habits. From the origin of medicine to the present time, the subject has engaged the attention of the medical world. Its important outlines were originally drawn from the vital phenomena alone. We learn from Plato, a cotemporary of Hippocrates, that the general doctrine of sympathy, in its application to the cure of disease, was considered fundamental by physicians. Thus: "Occulorum morbosos affectus sanari non posse, nisi prius curetur caput, neque caput nisi prius curetur corpus, neque corpus sine animo, aiebat medicus quidem apud Platonem."

463, *b*. When the nervous system became understood, this knowledge aided greatly an analysis of the laws of sympathy. "Glisson, in 1677, speaks of an influence being '*reflected*' from one nerve at its origin upon other nerves, so as to cause consensual movements." Unzer, in 1771, was close upon Bell's discovery, and Whytt and Monro also carried on the inquiry in conformity with the designs of structure. In 1784, Prochasca established the theory of reflex action of the nervous system. This great theory has been recently analyzed and reduced to a system of magnificent laws by Professor Müller, to which Dr. Hall and others have also made some contributions.

464. But, the present century contributes to medicine a discovery which lays open the precise mechanism that subserves the laws of sympathy. It consists, essentially, in having demonstrated the two orders of nerves (§ 462). With this mechanism, in its connection with the phenomena of sympathy, we move forward with unerring certainty to the exposition of principles and laws which are as peculiar to organic beings as their structure and results, and as determinate as the mechanism is replete with consummate Design.

465. The posterior roots of the spinal nerves, which have a ganglion upon them, denote the part appropriated to sensation, or to such impressions as may be transmitted from the periphery to the centre. The anterior roots, which are without a ganglion, exercise the motor function, and that range of influences upon which all the immediate and important results of sympathy depend (§ 226, &c.). The fibres of these roots are gathered into bundles, forming the nerves, and are thus distributed to various well-known parts; and what is of the high-

est moment in organic life, and mainly important to the purposes of these Institutes, these nerves contribute to the great sympathetic (§ 111–117, 129).

466. The motor and sensitive fibres of a common nerve do not unite, but are even distributed separately in the organs which they supply. They have, therefore, no action upon each other except through the nervous centres (§ 514).

467. All the late anatomical investigations of the spinal cord by Stilling, Van Deen, Budge, and others, go to confirm the foregoing conclusions (§ 465, 466). They have also probably indicated the anatomical mediums, in the spinal cord, by which impressions are conducted to the brain, and influences transmitted from that organ. Stilling, for instance, supposes that the longitudinal fibres of the posterior gray substance of the cord transmit the sensitive impressions to the brain, and that the longitudinal fibres of the anterior gray substance are the medium through which the will operates in voluntary motion.

468. The foregoing discovery has led to the knowledge that one of the functions of a nerve may be destroyed without impairing the other. If the posterior root be paralyzed or divided, sensation is destroyed, but not the power of motion. So, on the other hand, if the anterior root be divided or paralyzed, voluntary motion is destroyed, but not sensation; and, as organic motion is independent of the will, it is only influenced, not destroyed, by this injury of nerves (§ 205–208, 226, 257, 500).

469. The two orders of nerves occur in the great sympathetic, and appertain, also, to those nerves which proceed directly from the brain, where they are either compounded, as in the spinal nerves, or make up, respectively, distinct nerves of sensation and motion.

Those which proceed from the brain are distributed into three classes:

1st. "Nerves of special sense; namely, the olfactory, optic, and auditory nerves.

2d. "Mixed nerves with the double roots; the trigeminus, glossopharyngeus, (?) and the par vagum with its accessory, and, in several mammalia, the hypoglossus.

3d. "Single-rooted nerves, for the most part of motor function, which are either themselves entirely motor, and receive sensitive fibres from other nerves, or which, if their roots contain sensitive fibres, still cannot be classed with the double-rooted nerves. These are the occulo-motorius, the trochlearis, the abducens, and the facial nerve."—MÜLLER.

470. The nerves of the sympathetic system are exquisitely endowed with that modification of sensibility which I have denominated sympathetic sensibility (§ 201–203, 495, &c.). This modification is not less strongly pronounced in the sympathetic system than specific sensibility in the nerves appropriated to the organs of sense; for it is through this medium that all the organic viscera "feel," as it were, the condition of each other.

The nerves of the ganglionic system have only an involuntary motor influence upon the parts to which they are distributed.

"It being shown that the sympathetic regularly receives fasciculi of motor and sensitive fibres from the spinal nerves, as their motor

and sensitive roots, the existence of a similar relation between it and those cerebral nerves which are analogous to the spinal nerves, in having double roots, becomes very probable."—MÜLLER.

Laws of the Action of Motor Nerves of the Cerebro-spinal System.

471. 1. "The motor influence is propagated only in the direction of the nervous fibres going to the muscles, or in the direction of the ramification of the nerve; and never in a retrograde course."

2. "The application of mechanical or galvanic irritation to a part of the fibres of a nerve does not affect the motor power of the whole trunk of the nerve, but only of the insulated portion to which the stimulus is applied."

3. "A spinal nerve entering a plexus, and contributing with other nerves to the formation of a great nervous trunk, does not impart its motor power to the whole trunk, but only to the fibres which form its continuation in the branches of that trunk."—MÜLLER.

Laws of the Action of Sensitive Nerves of the Cerebro-spinal System.

472. 1. "When the trunk of a nerve is irritated, the sensation is felt in all the parts which receive branches from it. The effect is the same as if all the ultimate ramuscules had been irritated."

2. "The sensation produced by irritation of a branch of a nerve is confined to the part to which the branch is distributed, and generally, at least, does not affect the branches which come off from the nerve higher up, or from the same plexus."

3. "When, in a part of the body which receives two nerves of similar function, one is paralyzed, the other is inadequate to maintain the sensibility of the entire part. On the contrary, the extent to which the sensibility is preserved corresponds to the number of the primitive fibres unaffected by the lesion."

4. "When different parts of the thickness of the same nerve are separately subjected to irritation, the same sensations are produced as if the different terminal branches of these parts of the nerve had been irritated." The sensations, however, are greatly less in the former instance (§ 826, *d*).

5. "The sensations excited in the minute elementary fibres are transmitted from the surface of the brain, without being communicated to the other fibrils of the same nervous trunk."—MÜLLER.

The foregoing laws are relative to specific sensations, and are more or less applicable to sympathetic sensation (§ 450, 451).

Of the Spinal Cord.

473, *a*. 1. "In a physiological point of view, the spinal cord so far agrees with the nerves that it propagates actions of the nerves, which enter it, to the brain, just as the cerebral nerves communicate impressions made on them immediately to the sensorium commune; and that it communicates the influence of the brain to the nerves arising from it, which thus receive, through the medium of it, the cerebral influence, just as if they arose from the brain itself. In other respects, however, the spinal cord differs essentially from the nerves in possessing properties which belong to it as a part of the central organs, and do not reside in the nerves (§ 459).

2. "All the cerebral nerves are immediately subject to the influence of the brain, and all the spinal nerves are subjected to the same influence through the medium of the spinal cord. As soon as the transmission of this influence is interrupted, impressions on sensitive nerves cease to be propagated to the sensorium, and the brain loses the power of voluntarily exciting the motor action of the nerves which are withdrawn from its influence. When the communication of the brain and spinal cord with the nerves is interrupted by wounds, pressure, or paralysis, all the branches which are given off below the affected spot cease to be voluntarily excited by the motor action; and the action of external stimuli on the same parts produces no sensation.

473, *b*. "Those branches, on the contrary, which come off from the nerve above the point of injury are still subject to the influence of the brain and of volition, and, when irritated, give rise to sensation."

473, *c*. "The parts of a nerve below the injured point preserve, however, their motor power for a certain time. It is merely the influence of the brain upon them that is lost. The nerve does not lose its excitability to external agents until it has been several months cut off from intercourse with the brain" (§ 459 *c*, 461).

In organic life impressions may still be propagated to and from the brain upon parts situated below the point of interruption, through the sympathetic nerve, and although there be no other medium of communication than by the connection of the sympathetic nerve with the blood-vessels. This is an important consideration in forming conclusions from certain experiments upon the nerves, with a view, in part, to ascertain the modus operandi of morbific and remedial agents in their action upon organs distinct from each other.

3. "In man and the higher animals the spinal cord stands in the same relation as all the cerebral nerves to the brain. It is to be regarded as the common trunk of the nerves of the body; although it is, besides this, distinguished by special properties."

4. "The fibres of the spinal cord pass through the medulla oblongata to reach the sensorium commune. All the primitive fibres of the nerves terminate in the brain; those of the cerebral nerves immediately, those of the spinal nerves through the medium of the spinal cord."

5. "The spinal cord has the property of reflecting irritations of its sensitive nerves upon the motor nerves, but without itself perceiving the sensation" (§ 201–204, 451 *d*–451 *f*).

"The spinal cord, even when separated from the brain, and without any external stimulus, can excite automatic movements."

6. "The spinal cord, although capable of exciting the motor nerves to automatic actions, nevertheless, in the healthy state, leaves a great part of the motor nerves, those supplying the muscles of locomotion more especially, in a quiescent state; while on others it exerts a constant motor influence (§ 500, *k*). It thus maintains constant involuntary contractions, which are arrested only by the spinal cord becoming paralyzed. The motions of this kind are, 1st, those of muscles which are also subject to the influence of the will, as the sphincter ani; 2d, those of muscles not subject to the influence of the will, as the sphincter vesicæ urinariæ, the muscular coat of the intestines, &c."—Müller.

474. 1. "The activity of all the special functions of the nerves is

determined by the central organs, partly under the influence of the mind, and partly independently of this influence."

2. "The central organs connect all the nerves into one system. To this even the sympathetic nerves do not form an exception."

3. "The central organs are the exciters of the motor nerves which conduct the motor influence of the nervous principle to the muscles. This motor influence may be constant, as we see in the case of the sphincters; secondly, it may be evidenced in intermittent rhythmic movements, such as those of respiration; and, thirdly, the motor influence may issue voluntarily from the *sensorium commune* (the part of the brain on which the mind acts) to the central organs; this sensorium commune being subject to the spontaneous actions of the mind.

"The motor nerves are affected by this motor influence in two ways. First, the nerves of one class act as mere conductors of it. In their normal state they do not exert this power spontaneously, but only when excited by the central organs. These are the motor nerves of the cerebro-spinal system.

"Secondly, the nerves of the other class, which are quite withdrawn from the influence of the *sensorium commune*, as far as regards voluntary actions [not the passions], are likewise capable of being excited to *constant* and *periodical* action by the central organs. But they present the peculiarity of affording independent discharges of the nervous influence; although, after a time, communication with the central organs is found to be necessary for the production of the nervous power. Such are the sympathetic nerves with regard to their motor actions."

The first of the foregoing varieties of motor influence is the exciting cause of voluntary motion. By the second I interpret, in part, the operation of morbific and remedial agents upon parts not immediately connected with the direct seat of their action, and the phenomena of sympathetic diseases, and other sympathetic results among separate parts.

The former part of the next following law, and § 473 *c*, no. 5, have led me to distinguish the third kind of sensibility and sensation, which I have denominated sympathetic (§ 201–204, 451). Thus:

4. "Impressions conveyed by the sensitive nerves to the central organs are either reflected by them upon the origin of the motor nerves, without giving rise to true sensations, or are conducted to the sensorium, the seat of consciousness."

5. "The nervous influence is generated in the central organs." This is not universally true, since "*The maintenance of the excitability in the nerves does not, however, depend solely on the continuance of the influence of the central organs on them, but also upon their own activity.*"—MÜLLER.

It is still a problem whether the "activity" of the nerves here spoken of be not equivalent to a partial production of the nervous power. There are many facts which appear to denote a low degree of this office (§ 224, 461, 497).

475. It remains now to say, under the present section, that it is important that the hypothetical words *motor* and *sensitive*, and *senso-motory*, do not betray us into the belief that the nerves are the causes of motion, or that there is any sensation connected with the organic phenomena of sympathy (§ 201–215, 257, 222–233, 451). The term "*excito-motory*" is far preferable to *motor;* and *sensitive* it might be difficult to improve.

There is this among other distinctions of voluntary and involuntary motions: the nervous power is always necessary to the development of the former, but not always to the latter, though involuntary muscular motion in all the muscles that are more or less subject to the will is always excited by the stimulus of the nervous power. In organic life, the blood is the stimulus of the heart and vascular system, but the nervous power is one of the stimuli of the muscular coat of the intestinal canal, &c. (§ 514, *f*).

III. Experiments to determine the Laws of the Vital Functions.

1st. *On the Principle on which the Action of the Heart and Vessels of Circulation depend.*

476, *a*. I now come to certain important experiments by different observers, especially by Dr. A. P. Wilson Philip, as contained in his work on the Laws *of the Vital Functions.* It was the main object of those experiments to demonstrate the independence of organic functions of the nervous system; to show that those functions arise from the organic properties (§ 183, &c.); and they are perfectly triumphant. They have been often repeated, and their results as often verified. It may, therefore, be thought that a simple reference to those results would answer the objects of the present work. But, an age of materialism requires a constant appeal to the senses, as the only recognized mode of reaching the understanding (§ 234, 350¾ *k*); and, I have in view not only the great original objects of those experiments, but what is still more practically important, and peculiar to myself, the application of the experiments to the laws of sympathy as they govern the operation of morbific and remedial agents, having partially employed them for the last purpose to demonstrate the philosophy of the operation of loss of blood, in the *Medical and Physiological Commentaries*, vol. i., p. 161–173, &c. The experiments show us how it is that morbific or remedial agents, when applied to a part, may develop and modify the nervous power, and reflect it with various effect upon other parts (§ 226). They also place all the processes of living beings upon purely vital grounds; even the vegetable kingdom, by the force of an incontrovertible analogy.

476, *b*. Prior to the time of Haller, the nervous power was considered, in one way or another, as indispensable to the motions of the heart, and the brain was the seat to which the power was referred. Whytt had just before laid the foundation for rejecting the supposed necessity of the nervous system to organic life. Haller then took up the inquiry, and carried it forward by a multitude of experiments, and overthrew the doctrine of the necessity of the nervous system to organic actions (§ 167). The experiments of Philip confirm those of Haller, while, also, they are more conclusive. But he is entitled to the greater credit of demonstrating, experimentally, that organic actions are influenced by the nervous power, although it was clearly known to Whytt, Haller, and Prochasca, that such an influence obtains; while Haller, like Philip, separates it entirely from the natural relations of the nervous system to the organic functions. Prochasca, also, had ascertained, near the close of the last century, about all that is now more distinctly known of the doctrine of reflex nervous

power, or remote sympathy; but the nature of the principle, and the remarkable distinction in the constitution of the anatomical medium, were not shown till demonstrated by the experiments of Bell and Philip (§ 462–469). Hunter, reasoning upon the natural phenomena of healthy and morbid conditions, contributed largely to the inquiry. Bichat followed immediately after, and pointed out the natural distinction of the two lives, analyzed the tissues (§ 86–88, 96–101), and developed, more than his predecessors, the nature of the vital properties, and construed all the phenomena of life, healthy and morbid, by the normal and abnormal states of the properties of life.

476, *c*. It has been a question of difficult solution, how the passions should affect so sensibly the actions of the heart, while the will has no influence upon this organ. And so of all other organic viscera. This problem I have explained by showing that the will is a distinct element of the mind, as the passions are equally distinct. One determines the nervous power upon the voluntary organs, the other upon the involuntary; each having their great, specific, final causes (§ 188½ *d*, 205–208, 226, 233, 256, 486, 487 *h*, 492, no. 7, 500 *d–k*, 976). In the latter respect, the passions are exactly analogous to the influence of morbific or other foreign agents that may operate either directly or indirectly upon the brain; being, like those agents, capable of modifying the nervous influence in its relation to the actions of organic life, while the will is incapable of such modifying effect upon the nervous influence in its relation to the actions of animal life (§ 226–228, 233, 500 *d–k*). The principle is exactly the same as that which I have shown to relate to the several rays of the sunbeam. The facts in both the cases mutually illustrate and support the philosophy of each (§ 188½, *d*).

476½, *a*. The researches of Le Gallois upon the influence of the medulla oblongata and the spinal cord on organic actions led immediately to those by Wilson Philip, and others who embarked in the same inquiry. Le Gallois very happily analyzed the relations of the medulla oblongata to the respiratory function, and the various movements of the process, and showed that it was the most mortal part of the body, by its immediate control over that function. The subsequent discoveries of Sir Charles Bell as to the sensitive and motor nerves have shown, also, that it is in the medulla oblongata that the nervous respiratory influences have their centre.

476½, *b*. Le Gallois' experiments upon the spinal cord, and his inductions from them, and as sanctioned by others, are remarkable exemplifications of the fallacies to which results, artificially obtained, may conduct us, and supply a forcible illustration of the propensity of the mind to grasp at a single fact, and to draw important conclusions from it, to the exclusion of all others, however contradictory. It is mainly, however, as to the supposed dependence of the functions of the heart, intestines, and other organic viscera, upon the spinal cord, that these errors relate. A general summary of the observations will aid the inquirer after the philosophy of this subject. I am the more induced to present this outline from the misapprehensions which continue to surround the subject, even in the ranks of the most erudite physiologists. Thus, Dr. Marshall Hall, in his late *Memoir on the Nervous System* (1841), inculcates the following doctrines: "*The spinal marrow*," says Dr. Hall, "*exclusive of the cerebrum, is the* SOURCE

of animal life."—"*The* IRRITABILITY *of the muscles of organic life depends, probably, on the ganglionic system*" (§ 188–193. Also, my Essay on the *Modus Operandi of Remedies*, p. 42, in *Med. and Phys. Comm.*, vol. iii.).

476½, *c.* Such were the results of the experiments, and such their novelty, that, having led their author to the conclusion that the functions of the heart, and other organic viscera, depend upon the nervous power of the spinal cord, the doctrine was received with éclat by the French Institute, and, indeed, by all Europe, in defiance of the well-known fact that fœtuses have been born alive without brain and spinal cord, that the heart will palpitate for hours after its removal from the body, that the intestines will roll about upon the table, and that plants have the same great organic processes as animals. They simply took, as the ground of their conclusion, the safety of excision of the brain, or of its removal from the cranium, contrasted with the destructive effects of crushing the spinal cord (§ 5¼).

476½, *d.* The foregoing conclusion was inferred from the interruption of circulation by destroying the spinal cord by a wire thrust down the spinal column. The action of the heart, however, was not wholly arrested; but it failed to circulate the blood in the large arteries. This was supposed to be owing to a privation of the nervous power, by which the heart became enfeebled. Le Gallois also supposed that the actions of the heart were irregularly performed, which was also an error.

Next, he destroyed only small portions of the spinal cord, and the results led to the conclusion that it is not from the whole spinal cord that every part of the body derives its organic life, but from that part of it only from which the nerves are supplied. And, although this philosophy is wrong, the conclusion is right, that in destroying any particular part of the spinal cord, we only destroy life in those parts of the body which correspond to that part (§ 507–510).

476½, *e.* Now, although rabbits twenty-two days old have no difficulty in living for some time after the head is cut off, yet the fact was ascertained that the destruction only of the spinal cord destroyed life, at that age, in less than four minutes; respiration ceasing first. This experiment, especially, led to the belief that the principle of life upon which the heart depends resides in the spinal cord.

Le Gallois next ascertained that the destruction of either the dorsal or cervical portion of the spinal cord was fatal to rabbits of the foregoing age, even in a shorter time than that of the lumbar portion; that is, in about two minutes. The results, however, as to time, varied at different ages; and death took place soonest in parts that were opposite to the portion of the cord destroyed.

Now this sudden abolition of life, from a partial destruction of the spinal cord, was imputed by Le Gallois to the loss or extinction of the circulation; and this, regarded as a remote result, was in part true. But, as will have been seen, the immediate and essential effect consisted in the destruction of the organic properties of the heart and blood-vessels, by determining upon them, and all other parts embraced within the compass of experiment, a pernicious nervous influence by the sudden destruction of the spinal cord (§ 226, 227, 510). It also appeared to follow (and such was the conclusion), that the power, on which the motion of the heart depends, resides in the whole

of the spinal marrow; since the destruction of either cervical, dorsal, or lumbar portion, arrested the circulation. But here, again, we see the error of the conclusion; since a fatal nervous influence would be equally propagated upon the heart, not only through the continuous parts of the spinal cord and brain, but through the sympathetic nerve, by destroying any one of the three portions of the cord, and this, too, without the heart being in the least dependent for its motions upon any part of the spinal marrow (§ 458, 459).

476½, *f*. Such, however, was the effect of the foregoing influence upon the powers of the heart; and, as the blood-vessels are, also, prostrated in their action by the same cause, it is obvious, if the extent over which the blood circulates be lessened in proportion as the heart is enfeebled, the circulation will be prolonged in parts corresponding with the portions of the spinal cord that are not destroyed. It is only necessary, therefore, to apply ligatures around the principal arteries, to answer the intention. Hence, rabbits live much longer if the aorta be tied near its emersion from the diaphragm, before destroying the respective parts of the spinal cord. By the same rule, also, if the head be cut off, before destroying the cervical portion of the spinal marrow, life is supported much longer than when the head is on.

476½, *g*. It appears, therefore, that death resulted in Le Gallois' experiments partly from the propagation of the nervous power upon the vital properties, not only of the heart, but of all the organic viscera, and in part, also, by withdrawing the regulating medium of concerted actions, and thus deranging the organic relations (§ 129, 455, 510).

476½, *h*. Le Gallois found, to his surprise, and beyond his explanation, that if the spinal cord be slowly destroyed, the effects were greatly different from such as resulted from its sudden destruction; that is to say, the circulation was at once arrested when the cord was suddenly destroyed, but not so when gradually destroyed. This fact, in itself, is subversive of his principal conclusions; and the difference in results depends upon the greater violence of the nervous power when suddenly, than when more slowly excited (§ 479). This is also shown in paroxysms of joy and anger. These passions may kill on the instant, if suddenly excited, but never when gradually produced, whatever their ultimate intensity (§ 230). So a blow upon the region of the stomach, which shall not exceed in force ten pounds, may destroy life instantly, when a weight of one hundred pounds, gradually applied, may be wholly innoxious (§ 509). This is a very important law of the nervous influence, as it is in constant operation in the production and cure of diseases, whether the effects depend upon physical or moral causes. It is owing to the suddenness with which the nervous power is developed, that syncope may be occasioned by a very small loss of blood (§ 940, 961, 974), or when it proceeds from offensive sights, nauseous odors, or any mental emotion (§ 944). It is owing to the same principle, in part, that blisters often give more relief when they operate rapidly than slowly. It is an especial reason why emetics are often so suddenly curative in croup, &c.; all having their astonishing foundation in a common principle.

477, *a*. I now approach the important experiments which overthrow Le Gallois', and all the conclusions which were so extensively derived from them as to organic actions, and through which, in part, I

interpret all the laws of remote sympathy, all the effects of morbific and remedial agents upon distant parts when applied to the stomach, or skin, or lungs, &c.; of the remote influences of disease, and all the effects of the passions; of blows upon the epigastrium, and the suddenly pernicious influences of surgical operations; in short, of any unusual phenomenon which can be supposed to happen through the agency of the nervous power. It will be seen, also, that they corroborate, and are corroborated by, all the conclusions which I shall have drawn as to the nervous power, and the laws of remote sympathy, from the phenomena of natural and morbid conditions, and from the discoveries in relation to the two orders of nerves (§ 464).

Unless otherwise stated, the experiments are by Philip. A large number are omitted, as unnecessary to my purposes.

477, *b. Experiment* 1. "A rabbit was deprived of sensation and voluntary motion by a blow on the occiput. Respiration ceased, but was kept up artificially. The spinal marrow was then laid bare from the occiput to the dorsal vertebræ. The chest was next opened, and the heart was found beating with considerable force. The whole cervical portion of the spinal marrow was then removed, and without affecting the action of the heart. The skull was then opened, and the whole brain removed, so that no part of the central organs remained above the vertebræ. There was, however, no abatement of the action of the heart. By suspending artificial respiration, however, about an hour and a half after the removal of the brain, the heart ceased to beat; but its action was again restored on renewing the respiration.

Exp. 2. "Having rendered a rabbit insensible by a blow on the occiput, Philip destroyed the whole spinal marrow by a hot wire. Respiration was supported artificially, and, on dividing the carotid artery, the blood spouted out.

Exp. 3. "A rabbit was rendered insensible by a blow on the occiput, and artificial respiration performed. The spinal marrow, from the base of the skull to the beginning of the dorsal vertebræ, was removed, and the remaining part of it was destroyed by a hot wire. The carotid artery was then found beating, and, on dividing it, the blood rushed out with great force, *per saltum.*

Exp. 4. "In another rabbit, insensibility was produced in the foregoing manner, the whole spinal marrow removed, and artificial respiration not performed. The carotid artery being divided, dark-colored blood flowed *per saltum.* The lungs were then inflated, and florid blood began to spout out of the artery.

Exp. 5. "In this experiment the rabbit was rendered insensible, but not motionless, by a blow on the occiput, and natural breathing continued. The spinal cord was then destroyed by a hot wire. A femoral artery was now opened, and the blood spouted out. Then the other femoral artery was opened, from which the blood flowed copiously, and continued to flow for seven minutes; when one of the carotids was opened, from which blood issued in a full stream, and till most of the blood was evacuated.

Exp. 6. "The brain of a frog and the spinal marrow, as low as the dorsal vertebræ, were laid bare. The thorax was then opened, and the heart found acting vigorously. The part of the spinal marrow which had been laid bare was then removed, but without at all affect-

ing either the motion of the heart, or the passage of blood through it. The brain was then removed with the same result.

Exp. 7. "The brain and spinal marrow of a frog were removed at the same time. On opening the thorax the heart was found performing the circulation freely.

Exp. 8. "A ligature was applied to the neck of a frog, the head cut off, and the spinal marrow destroyed by a wire. The circulation in the web continued afterward, for many minutes, as vigorous as in that of a healthy frog.

Exp. 9. "The spinal marrow and brain of a frog were destroyed by a wire. The animal appeared quite dead for several minutes, during which the circulation was seen in the web as vigorous as in that of a healthy frog."

478, *a.* The foregoing and following experiments disprove the conclusions derived from Le Gallois', that the power, on which the motion of the heart depends, resides in the spinal cord, and in all parts of it. They also establish, what had been sufficiently shown by the heart when severed from the body, that its action is independent both of brain and spinal cord; and the proof extends equally to the blood-vessels. "From various trials," says Dr. Philip, "we found that the circulation ceases quite as soon without, as with the destruction of the spinal marrow. Loss of blood seems to be the chief cause which destroys the circulation." "The result is still more striking in cold-blooded animals, in which death takes place so slowly, that the circulation continues long after the total destruction of the brain and spinal marrow" (§ 257).

478, *b.* The experiments prove, what will be more fully shown, that, to influence the action of the heart through the nervous centres, some impression must be made either upon the brain or spinal cord, since their mere removal does not affect the action of the heart, nor of the blood-vessels; and this will be seen to be essentially true of all other organic actions, not excepting even the peristaltic motion of the intestines. In this last instance, however, a constant determination of the nervous power upon the intestinal muscular tissue, by irritation propagated to the nervous centres from the mucous coat, operates as a stimulus in maintaining, in part, the muscular action.

478, *c.* The experiments prove, in connection with others to be related of the same nature, that the actions of life are carried on by powers or properties inherent in each part (§ 184).

478, *d.* They prove that when death suddenly follows a division of the medulla oblongata, or a simple removal of the brain and spinal cord, it does so essentially from abolishing respiration.

479. A practical consideration of great moment grows out of the difference in the modes in which the foregoing experiments were performed by Philip and Le Gallois, and the vast difference in the results. The discrepances in results were owing entirely to a difference in the size of the wires by which the two experimenters destroyed the spinal cord; Le Gallois having employed a wire that filled the cavity of the spinal column, and thus destroyed the spinal cord suddenly, while Philip used a smaller wire, and destroyed the cord gradually; or it was removed, along with the brain, without farther injury to them. In Le Gallois' experiments, therefore, the nervous influence was suddenly and powerfully transmitted through all the nerves leading from

the spinal cord, as well as the sympathetic; while in Philip's, it was so gradual and imperfect, that it was not determined with destructive violence upon the organic properties of the heart and blood-vessels, though always with a more or less prostrating effect at first. So, too, of the sudden or gradual destruction or removal of the brain. What, also, is thus true of the heart and blood-vessels (as will farther appear), is equally so of all the other organic viscera (§ 476½ *h*, 509, 510, 947).

2d. *On the Relation which subsists between the Heart and Vessels of Circulation, and the Nervous System; and the Influence of the Nervous System upon the Capillary Blood-vessels.*

480. The following experiments are much more important than the preceding in ascertaining the existence of the nervous power, how it may be variously excited, how variously modified by artificial causes, and how it may be determined with various effects upon the organic functions. These, with another group relative to the stomach and intestines, open to us the modus operandi of the passions in organic life, of morbific and remedial agents in their effects upon parts distant from the direct seat of their operation, of sudden deaths from injuries distant from the nervous centres, of the sympathies from diseases, &c.; when taken in connection with what is known of the sensitive and motor nerves, and the reflections of the nervous power, as set forth in the laws relative to this subject (§ 462–470, 512–524).

The object in producing insensibility was to prevent all agitation of the animals, that the effects of the stimuli, &c., might be most advantageously observed.

Experiments relative to the Heart in its Connection with the Nervous System.

481, *a*. *Experiment* 10. A rabbit was deprived of sensation and voluntary motion by a blow on the occiput, artificial respiration performed, and the brain and cervical part of the spinal marrow laid bare. The thorax was then opened, and the heart observed to beat with strength and regularity. *Spirit of wine* was then applied to the spinal marrow, and a *greatly increased* action of the heart was the consequence. It was afterward applied to the brain with the same effect. The increase of action was immediate and decided in both cases, and as great in one as in the other. The effect of the *blow* upon the head, in all the cases, was to *lessen* the frequency of the pulsations; as generally happens in apoplexy.

Exp. 11. The foregoing experiment was repeated, with the difference, that the whole of the spinal cord was laid bare. The motion of the heart was nearly, if not quite, as much influenced by the application of the alcohol to the dorsal, as to the cervical portion of the spinal marrow; but it was very little influenced by its application to the lumbar portion.

481, *b*. We see, therefore, that experiments 10 and 11, independently of the more important ones which follow, illustrate the most essential elements that are concerned in remote sympathy, and in the operation of the passions upon organic actions, in their connection with what has been said of the sensitive and motor nerves and their relations to each other (§ 462–475). When, for instance, a morbific or remedial agent, applied to the stomach or skin, influences a remote

part, and produces, or removes, disease in that part, its primary impression is transmitted to the brain and spinal cord by the sensitive nerves, where the impression acts upon the central organs just as the alcohol did in the foregoing experiments, and, like that, it develops the nervous power which is then reflected through the incident nerves upon remote parts, just as it was to the heart in the application of the alcohol.

As to the passions, they are exactly equivalent to the action of agents applied directly to the brain, and develop and modify the nervous power in the same direct manner. Such as are exciting, are analogous in their effects to those of alcohol; such as are depressing, to those of tobacco, opium, &c. (§ 227–230). From the equal effect of the alcohol, also, when applied directly to the spinal cord, it is evident that the nervous power is also generated in this part, as it is, more or less, in all the nerves.

When, however, the nervous influence is developed by the primary action of alcohol on the stomach, and the action of the heart is increased in consequence, the development of the nervous influence is indirect; just as it is in respiration (§ 500). But, in all these cases, the nervous influence is developed in the brain and spinal cord, by the transmitted impression, just as it is by the alcohol when applied directly to the nervous centres; the transmitted impression being exactly equivalent to the direct action of the physical agent upon the central parts.

481, *c.* It is now important to observe in the relative experiments upon the brain and spinal cord, that when they exist in connection, the influence of agents applied to the cord, in developing the nervous power, may be mostly exerted upon the brain (§ 459).

Exp. 12. "Preparation the same as in Exp. 10 and 11, excepting only the anterior part of the brain was laid bare. The spirit of wine applied to this part of the brain produced as decided an effect on the motion of the heart as in Exp. 10 and 11. The spirit of wine was washed off, and a watery solution, first of opium, then of tobacco, was applied, with the effect of an increase, but of a much less increase of the heart's action, than arose from the spirit of wine. The increased action was greater from the opium than from the tobacco. The *first* effect of both was *soon succeeded by a more languid action* of the heart than that which preceded their application to the brain. This effect was greatest and came on soonest when the tobacco was used; and there was always observed, for the experiment was frequently repeated, *an evident increase in the action of the heart when the tobacco was washed off.* This was also seen, though in a less degree, when the opium was washed off. Little or none of this debilitating effect was observed when the spirit of wine was used. After its stimulating effect had subsided, the action of the heart only returned to about the same degree as before the application of the stimulus.

Exp. 13. "The foregoing experiment was repeated on an animal of cold blood. In this case a frog was deprived of sensibility, in less than a minute, by immersing the hind legs in the tincture of opium. Alcohol, and watery solutions of opium and tobacco, were applied to the brain and spinal cord, as in Exp. 12, and with precisely the same effects. The application and *washing off* of the stimulant and sedatives were frequently repeated in this experiment with the same results.

It is remarkable that we could affect the motion of the heart by the agents applied to the brain and spinal marrow *after they had all ceased to produce an effect on the muscles of voluntary motion* through the medium of the nervous system. The action of the heart could be also influenced by these agents applied to the brain and spinal marrow *long after the circulation had ceased.*" Of course, therefore, no action by absorption.

Exp. 14. "This experiment only differed from the last in the cervical part of the spinal marrow and lower part of the brain being removed, and the agents applied only to that part of the brain which lies between the eyes of the frog. Spirit of wine, opium, and tobacco, thus applied, affected the motion of the heart quite as much, and precisely in the same way, as when they were applied to the entire brain or spinal marrow.

"The action of the heart, in the foregoing experiment, could be influenced by agents applied to the brain and spinal marrow *long after the circulation had ceased.*"

481, *d.* In Exp. 12, 13, and 14, we have an illustration of the modification of the nervous power according to the nature of the agents employed, while the effects correspond with such as are produced by the same agents when taken into the stomach (§ 226, &c.). It will be also observed that the effects are parallel with those of the different passions; those of the alcohol corresponding with the effects of anger and joy, and those of opium and tobacco with such as arise from grief, fear, &c. I hold, that the doctrine which I have propounded as to modifications of the nervous power is established by these experiments; though abundantly shown by the phenomena arising from morbific and remedial agents. There is no other intelligible solution of the problems which they supply. In the experiments, too, it will be conceded that the nervous power was the efficient cause of the results; from which it follows, that the nervous power must be in different states when it is excited by alcohol, opium, and tobacco, corresponding with the differences in effects.

481, *e.* The foregoing Exp. 12, 13, and 14, independently of the multitude of other facts, also completely refute the doctrine of the operation of morbific and remedial agents by absorption. It will be observed that in these experiments the action of the heart could be influenced by the agents applied to the brain and spinal cord "long after the circulation had ceased." This circumstance, besides its bearing upon the doctrine of absorption, shows us how the heart is roused into action, in cases of syncope, by the application of stimulants to the nose, cold to the surface, &c. (§ 945).

Exp. 15. "The spine of a rabbit was divided near the head, and the spinal marrow destroyed by means of a wire. Spirit of wine was then applied to the brain, which influenced the action of the heart as readily, and to as great a degree, as it does when the spinal marrow is entire."

481, *f.* This experiment demonstrates the difficulty of forming proper conclusions as to the special functions of the brain and spinal cord, and of different parts of the brain, by any experiments (§ 459, *a*). It shows, however, that the action of the heart may be as powerfully influenced through the brain when the spinal marrow is destroyed, as when it is entire.

481, *g*. I now come to those experiments which farther illustrate the principle concerned in the sudden production of death by blows on the epigastric region, surgical operations, small loss of blood, joy, anger, &c. They also go to interpret the modus operandi of morbific and remedial agents as to their rapidity and intensity, especially when taken in connection with Exp. 10–15, and others which are to follow. The effects now supposed depend on the rapidity and intensity with which the nervous power may be excited, and reflected not only upon the heart, blood-vessels, stomach, &c., but upon the brain itself, as also upon the manner in which the nervous power may be modified by the nature of the agent, as in Exp. 12 and 13.

If the head and spinal marrow of a frog be removed, the heart continues to perform its functions perfectly for many hours, nor does it seem at all immediately affected by their removal. But, we find the effect very different when the most sudden and powerful agent is applied to them. If they are even destroyed by being sliced away, the heart, after this mode of destruction, beats on as usual. But, if either the brain or spinal cord be instantly crushed, the heart feels it immediately and forcibly. Thus:

Exp. 16. "The thorax of a large frog being opened, the brain was crushed by the blow of a hammer. The heart immediately performed a few quick, weak contractions. It then lay quite still for about half a minute. After this, its beating returned, but it supported the circulation very imperfectly. In ten minutes after, its vigor was considerably restored; when the spinal marrow was crushed by one blow. The heart then beat quickly and feebly for a few seconds, and then seemed wholly to have lost its power. In about half a minute, it again began to beat, and in a few minutes acquired considerable power, and again supported the circulation. It beat more feebly, however, than before the spinal marrow was destroyed. It ceased to beat in about an hour and a half after the brain had been destroyed. In another frog, after the brain and spinal marrow had been *wholly removed*, the heart beat nine hours, gradually becoming more languid."

Exp. 17. "The foregoing experiment cannot be performed in the same way on warm-blooded animals, but it may be performed in a way equally satisfactory. In two rabbits the brain was crushed by a blow. In both the heart immediately beat with an extremely feeble and fluctuating motion. The anterior part of the brain only was crushed in another rabbit, with the same result. A strong ligature was thrown around the neck of a fourth rabbit, and at the same moment it was tightened, the head was cut off. The heart continued beating regularly, in this case, and not more quickly than in health. All the rabbits were of the same age."

Exp. 18. The following is still more conclusive:

"The anterior part of the brain of a rabbit was crushed by a hammer. No motion of the heart was perceived by applying the hand to the side. The head was cut off, about three quarters of a minute after the brain had been crushed. No blood spouted out, and very little ran from the vessels. A strong ligature was passed round the neck of another rabbit of the same age. It was suddenly tightened, and the head cut off. In this instance the heart was found beating regularly under the finger for about three quarters of a minute. At

the end of this time, the ligature was slackened, and the blood spouted out to the distance of three feet, and continued to spout out with great force, till nearly the whole blood was evacuated."

481, *h*. The last of the foregoing comparative experiments goes with others in demonstrating the error of the common opinion, that when the action of the heart and blood-vessels, or other organic functions, fail by crushing the brain, it is owing to the withdrawal of the nervous influence. But, still more conclusive is the fact that the entire brain and spinal cord may be removed without any present effect upon the actions of the heart and blood-vessels, as in Experiment 7. By this, and other considerations, I have endeavored to show that when syncope arises from loss of blood, it is not owing, as has been supposed, to the failure of the nervous influence upon the organs of circulation, but that this influence increases on the approach of syncope, is a principal cause of the paroxysm, and is actually greatest when the paroxysm is complete (§ 947, 948, and *Medical and Physiological Commentaries*, vol. i., p. 168–176).

482. The preceding experiments determine a variety of important points, of extensive physiological, pathological, and therapeutical application, and to which brief references were made. The whole should be viewed in connection, and also with such as are to follow; while a constant reference should be had to the laws of sympathy, as set forth in the fifth division of our subject.

Experiments relative to the Arteries in their Connection with the Nervous System.

483, *a*. The next important step in our inquiry is to ascertain, in a more specific manner than the preceding experiments, *how far the vessels of circulation are capable of being influenced through the brain and spinal cord.*

To determine the foregoing problem, it is first necessary to settle another; namely, *how far the vessels of circulation can support the motion of the blood independently of the heart.* That the small arteries possess this power in an eminent degree has been already rendered sufficiently certain (§ 392, 393. Also, *Med. and Phys. Comm.*, vol. ii., p. 145–151, 398, 422, &c.). But we now arrive at the same knowledge by another process.

As a comparative experiment, Philip passed a ligature round all the vessels attached to the heart of a frog, and then *cut out the heart.* "On bringing the web of one of the hind legs before the microscope, *the circulation was found to be vigorous*, and continued so for many minutes; at length gradually becoming more languid."

Now, if the heart be allowed to remain, whatever impression made upon the brain shall suddenly diminish or arrest the circulation in the capillary arteries, will prove that these vessels, as well as the heart, may be influenced by the nervous power.

Experiment 19. "The web of one of the hind legs of a frog was brought before the microscope, and while Mr. Hastings observed the circulation, which was vigorous, Dr. Philip crushed the brain with a hammer. The vessels of the web instantly lost their power, the circulation ceasing. In a short time the blood again began to move, but with less force than natural. This experiment was repeated, with the

same result. *If the brain be not completely crushed, the blow increases the rapidity of the circulation in the web.*"

The next experiment corresponds with those of the foregoing, which denote that the effects of the nervous power upon the organic proper ties and functions depend upon the manner in which it is developed modified, and reflected.

Exp. 20. "The spine of a frog was laid open at the lower end, and a wire, of nearly the same dimensions with the cavity of the spine, forced through it, as in Le Gallois' experiments. The circulation was found to have wholly ceased in the web of the hind leg."

Now mark the contrast when a small wire was employed; for, in another frog the spinal cord was destroyed by introducing in the same way, and moving in various directions, a wire much smaller than the cavity of the spine. The frog soon appeared to be quite dead; but the circulation in the web was found to be vigorous.

Exp. 21. "Part of the cranium of a frog was removed, the web of one of the hind legs brought before the microscope, and the circulation in it observed. The animal was now rendered insensible by the immersion of the other hind leg in laudanum. The insensibility did not in the least affect the circulation in the web before the microscope. Spirit of wine was then applied to the brain with an evident increase of the velocity of the blood in the web. The same effect was produced in a less degree by watery solutions of opium and tobacco. After the tobacco had been applied for about half a minute, the motion of the blood was much less rapid than before its application. *On washing off the tobacco, the velocity of the blood was increased, and was again lessened on applying it.* This was repeated several times with the same effects. When the circulation in the web had almost ceased after the tobacco had been washed off, *its velocity was increased on applying spirit of wine to the brain.*"

Analogous experiments, but varied from the foregoing in some of the details, gave the same results.

483, *b*. It may be proper to add, that Dr. Hall attempted to invalidate Philip's experiments with alcohol, &c., applied to the nervous centres, by repeating just *one* of them, and that one the least important of any. It was the least important, because it was made upon a cold-blooded animal, and because, also, the state of insensibility was produced by laudanum; the experiment being no. 21, or the last of the foregoing series. Of that experiment he says, that the motions of the heart were not affected on applying alcohol to the brain. It does not appear that he tried the effect of the infusions of opium and tobacco, nor that he repeated those far more important experiments upon warm-blooded animals.

The difference in the results is of the easiest explanation. By Dr. Hall's method of producing insensibility by the long-continued and extensive application of laudanum to the surface of the animal, the sedative effect of the nervous influence was so powerfully determined upon the circulatory organs, that alcohol, when applied to the brain, failed of rousing the action of the heart. In Philip's experiment, it is obvious that the cutaneous application of the laudanum was of short duration, and this was only relative to a few upon frogs. Dr. Hall, indeed, seems to have been aware that this objection might be raised against his experiment; for he remarks that, "I believe that there

may be one difference between Dr. Philip's experiment and my own (that is), I might apply the laudanum *more effectually*." It is this difference which makes all the difference in the results.

Finally, the force of Dr. Philip's experiment is increased by the very objection which has been made to the production of insensibility by laudanum; since his subsequent application of a watery infusion of opium to the brain influenced the heart and blood-vessels as in those cases where insensibility had been effected by other means. And so of the following like experiments by Alston, and by Dr. Hall himself.

483, *c*. There is one more fact connected with the present stage of my inquiry, which it may be well to consider, and by which Dr. Hall would invalidate, still farther, the conclusion drawn by Dr. Philip from his experiment of crushing the brain. In this experiment the action of the heart is temporarily suspended. Now, Dr. Hall would argue that this suspension is not the result of any special influence exercised by the brain over the heart, during the act of violence, because the same effect will follow when the stomach is violently crushed after removal of the brain and spinal cord. Thus:

"In an eel, in which the brain had been removed, and the spinal marrow destroyed, the stomach was violently crushed with a hammer. The heart, which had previously beat vigorously sixty times in a minute, stopped suddenly and remained motionless for many seconds. It then contracted; after a long interval it contracted again, and slowly and gradually recovered an action of considerable frequency and vigor."

Dr. Hall, therefore, argues that the nervous system had no agency in transmitting influences of the injured stomach to the heart, and that, "the organic structures (meaning others than the nervous) must have been the medium through which the effect of the violence was conveyed to the heart."

I need not go far to indicate the capital error of Dr. Hall's conclusion, so opposed to the phenomena of the passions, and the well-known effects of cerebral hemorrhage, and blows upon the head. It is sufficient, notwithstanding the removal of the brain, and the destruction of the spinal cord, in the case of the eel, that the whole ganglionic system, all the spinal nerves, and the pneumogastric besides, remained entire. It was therefore through this vast range of most important nerves, through the great solar plexus of the sympathetic, through the whole of the *anancephalous* system of nerves (§ 461½), that the nervous influence was propagated to the heart by crushing the stomach of the animal. Had, however, the brain and spinal cord been permitted to remain, the demonstrations of nervous influence upon the heart would have been more strongly pronounced. Nor was it a fair experiment, to have selected a cold-blooded animal, and so tenacious of life as the eel, to contrast an important result with such as had been obtained by a very different experiment upon a warm-blooded animal.

But, as I have said, slight blows over the stomach of *a man* may destroy his life in an instant, when they would be harmless to an *eel*. Hunter, and others, relate instances of instant death when extirpating a testicle, or performing minor operations; and Mr. Travers, and others, from lancing a thecal abscess of the finger, and other similar

slight causes. Here, it cannot be denied, that a fatal sympathy was propagated from a finger over the whole frame of *a man*, without calling to the explanation "the ten thousand" facts that are well established as to the influence of the nervous power upon organic actions; while we thus arrive at the obvious conclusion, that it is through the same principle blows upon the epigastrium, crushing the liver, and similar injuries, produce their fatal effects.

But, if we concede to Dr. Hall the inconsistency in which he is involved by his experiment, and by his direct affirmation that sympathies in organic life are owing to the mutual influences of organs among each other, and without the agency of the nerves with which they are supplied, it would not affect the principle which relates to sympathy in its aspect of an important law which is constantly concerned in disease and in the operation of remedial agents. The dispute would then turn only on the nature of the cause upon which the function of sympathy depends; while the very cases of disease which Dr. Hall produces to illustrate the existence and nature of the principle are fatal to his humoral hypothesis.

But the accuracy of all Dr. Philip's experiments has been fully ascertained by numerous physiologists.

484, *a.* I shall now introduce a series of experiments by other hands, which illustrate, still farther, the applicability which I have indicated as to the preceding experiments.

In the Edinburgh Medical Essays for 1733, vol. v., p. 128, are to be found the first experiments which I shall now mention, and which appear to have been neglected by later observers. They were made by Dr. Alston, who had no theory in view to embarrass his vision or judgment.

Exp. A. "I conveyed," says Alston, "through a small glass tube a few drops of a solution of opium in water into a frog's stomach, and putting the animal into a glass cylinder, adapted it so to a good microscope, that we had a distinct view of a part of the membrane between the toes of its hinder foot, where the circulation of the blood may be easily seen. My design was, since I found opium killed frogs, to observe if there was any visible change made by it in the blood itself, or in its motion. Neither of us could, indeed, see any alteration of the blood as to its consistence, color of the serum, magnitude, figure, or color, of the red globules; *but we very distinctly saw a surprising diminution of the blood's velocity*, for it did not move *half so swiftly* as it naturally does in those creatures. We alternately looked at it, again and again, and in *less than half an hour saw the velocity of the blood gradually increase.* The uneasy frog recovered its wonted vigor, and the blood its common velocity."

The foregoing experiment was repeated, after awhile, upon the same frog. Alston goes on thus:

Exp. B. "I put the frog into a basin of clean water, and allowed it half an hour to refresh itself; then gave it another dose of opium. The blood then moved yet slower than it did the first time, and its velocity gradually decreasing, it at length stagnated, first in the smaller, then in the larger vessels, and in about a quarter of an hour the animal died." The experiments were frequently repeated, with the same results.

Exp. C. The following experiment was performed by Dr. Marshall Hall:

"I applied laudanum," he says, "over the back part of a frog, carefully avoiding its contact with the web. In less than half an hour, its respiration and all sensibility had ceased, and the capillary circulation became, at the same time, more indistinctly pulsatory in the arteries, and more and more slow and feeble in the capillary vessels and veins. This effect became gradually more marked, and in two hours *the circulation had ceased almost entirely in all the three sets of vessels. I now washed off the laudanum, and placed the frog in water. The circulation at first gradually, afterward more speedily, returned, and became very vivid and vigorous,* EVEN BEFORE THERE WAS THE SLIGHTEST RETURN OF RESPIRATION (§ 441, *d*). The respiration and sensibility at length also returned completely. The laudanum was reapplied and again removed *with precisely the same effects.* The *insensibility* was so perfect that the eyes were not retracted on being touched. *The recovery was prompt and complete.*"

Exp. D. The foregoing experiment was repeated with opium and water; when the effects were less rapid, but "at length the circulation in the web ceased, and the animal became affected with complete tetanus."

Exp. E. "The same effect was produced more speedily on inducing the animal to swallow a few drops of the opiate solution."*

484, *b*. I have now to notice six principal points relative to the experiments A, B, C, D, and E.

1st. In Dr. Hall's experiments (C and D), the opium was applied to the skin exclusively.

2d. The effects were exactly the same as obtained by administering opium by the stomach (Exp. A, B, and E).

3d. The effects in both cases were similar to those obtained by Philip from applying opium to the brain, both in cold and warm-blooded animals.

4th. The experiments by Hall and Philip fully corroborate the obvious conclusion from Alston's (Dr. Hall's being only a repetition of Alston's), that opium does not produce its effects by absorption into the circulation (as is especially supposed of this agent), since in all the experiments, and the same with tobacco in one (§ 483, Exp. 21), the effects upon the circulation went off as soon as the solutions were washed from the skin, or from the brain, and returned when they were again applied, and again promptly disappeared when the solutions were washed off. Brodie's experiment with tobacco is also in direct proof of its universal operation through the nervous centres (§ 904, *b*).

5th. It appears from the foregoing facts, that the circumstances attending the effects of opium upon the system at large are the same, whether it be applied to the nervous centres, to the stomach, or to the skin. It follows, therefore, in connection with what is known of the influences which the brain and spinal cord may exert on the actions of organic life, that the remote effects of opium, applied to the stomach or skin, are produced by a modification and determination of the nervous power upon distant parts (§ 226, &c.).

Here, then, we see, more and more clearly, the propriety of the application which I have made of Philip's experiments, and which will become more strikingly obvious by connecting them with the sequel,

* HALL, *on the Influence of the Brain and Spinal Marrow upon the Circulation,* p. 111.

and with the results of Sir C. Bell's discovery. Let us suppose, for instance, that we have no other knowledge of the principle upon which remote sympathy depends, than the natural phenomena which are constantly manifested. We should certainly know, from these results, that such a principle exists; but where, or how developed, or how varied in its influences, we could not know with certainty without direct experiment. With the advantage, therefore, of such experiments as Philip's, we arrive at the clearest demonstration of the manner in which effects now under consideration are brought about, and thus put an end to the worst speculations in medicine. But, before reasoning from these experiments, we first look at the manner in which impressions are transmitted to the brain and spinal cord by the nerves of sensation, how they are reflected from these central organs, and the obvious results which follow in animal life, and how these results correspond with similar effects in organic life (§ 500). The foundation of an important philosophy is thus laid by demonstration, and rendered acceptable to those who rely only upon the plainest testimony of sense (§ 234).

6th. Again, I say, since the action of opium, through the stomach or skin, upon remote parts, is different from that of tobacco, alcohol, &c., and since each produces, respectively, the same effects when applied directly to the brain or spinal cord, and, in all the cases, by exciting and reflecting the nervous power, it follows that this power, like the organic powers, is capable of being modified in its nature according to the nature of the causes by which it is developed (§ 226–233, 494 *c*).

485. Finally, Kriemer has multiplied experiments to a great extent with reference to the part which the arteries take in the circulation, and they all concur in proving their independent action, and that they may be powerfully affected by impressions made upon the nerves When he tied the crural nerve of quadrupeds, it lessened immediately the jet of blood from the femoral artery. The same experiment on frogs arrested the capillary circulation in the web of the foot. What is also an important fact as showing an alteration of the organic properties of a part by the nervous influence, he observed that the arterial blood passed on to the veins without being converted into venous blood (§ 399, 507).

3d. *On the Principle on which the Action of the Muscles of Voluntary Motion depends, and the Relation which they bear to the Nervous System.*

486. Philip next proved by experiments that the muscles of voluntary motion, like the heart and blood-vessels, are independent of the brain and spinal cord, as it respects their excitability and power of motion; but that they are alike capable of being stimulated through the nervous system. "We do not, surely," he says, "in the experiments which have been laid before the reader, see any difference in the nature of the muscular power of the heart, and that of the muscles of voluntary motion, except their being fitted to obey different stimuli; a difference which we find in the two sides of the heart itself" (§ 136, 188½–190, 487 *e*).

4th. *Interesting Experiments were made by Philip to ascertain the comparative Effects of Stimuli applied to the Brain and Spinal Marrow on the Heart and Muscles of Voluntary Motion.*

487, *a.* I shall state only a few of the important practical conclusions. Thus: "Another circumstance, which appears to be of great importance in tracing the cause of the different effects of stimuli applied to the brain and spinal marrow, or the muscles of voluntary and involuntary motion, is, that the heart obeys a much less powerful stimulus than the muscles of voluntary motion do. We have seen that only the most powerful chemical stimuli affect them, while all that were tried readily influenced the action of the heart and blood-vessels."

487, *b.* The foregoing shows us the distinction between the irritability of the heart and voluntary muscles, &c., how it is differently affected in organic and animal life by the same agents, how the nervous power acts upon that irritability according to the nature of the agents by which it is excited, whether they be applied directly to the nervous centres, or to the stomach, &c. (§ 133–162, 188½–190, 222–233, 205, 206, 208, 209, 256, 484).

487, *c.* But, it is remarkable, that, although the voluntary muscles may be much more sensibly affected by agents applied to the brain, or spinal cord, than the organic actions, yet, as the animal approached a state of death, he found that, "after all stimuli applied either to the brain or spinal cord had ceased to produce any excitement in the muscles of voluntary motion, both chemical and mechanical stimuli, so applied, still increased the action of the heart; and *the irritating agents more than the mechanical.*"

487, *d.* It was also found by comparative experiments on the actions of animal and organic life, "that irritating or depressing agents, such as alcohol, alkalies, opium, tobacco, &c., applied to the brain, and spinal cord, exert a greater power over the heart than mechanical stimuli (such as variously injuring the structure of the brain), while the mechanical stimuli exert a greater power over the muscles of voluntary motion than the agents possessing peculiar intrinsic virtues."

487, *e.* Again, it was found "that stimulating every part of the brain and spinal cord equally affects the action of the heart (also, the stomach and lungs), while the muscles of voluntary motion are only excited by stimuli applied to the parts of those organs from which their nerves originate; that stimuli applied to the brain and spinal cord never excite irregular action of the heart, while nothing can be more irregular than the action they excite in the muscles of voluntary motion; that their effect on those muscles is felt chiefly on their *first* application, *but continues on the heart* (and blood-vessels) *as long as the stimulus is applied*" (§ 233½, 506, 516, no. 6).

487, *f.* In connection with this comparative inquiry, Philip has a remark which is worthy of deep consideration. "It is true," he says, "that although the heart is only influenced by agents applied to a large portion of the brain, we may conceive them so applied as to produce irregular action in it; and we find that certain irritations of the nervous system have this effect. But it is evident that the heart, not being subject to stimuli whose action is confined to a small por-

tion of this organ, and being equally affected through all parts of it, must render it much less subject to irregular action; which may be one of the final causes of the heart (whose regular action is of such importance in the animal economy) being made subject to the whole, and not to one part of the brain, and readily accounts for our not being able to produce irregular action in it by experiments upon the brain and spinal marrow." "When, indeed, the source of the nerves of the heart is considered, it will be found to derive its nervous influence from every part of the nervous system, and not very remarkably from any one part; a circumstance which particularly corresponds with the results of the foregoing experiments,"—and with the phenomena of sympathy as manifested in disease.

The same observations are also applicable to all the other organic viscera; which farther proves that the great final cause of the ganglionic system is to unite the organs of organic life in one concerted action.

487, *g*. By the same facts we may explain why the heart and other organic viscera are affected through the brain, and spinal cord, after their power is so far weakened as no longer to convey the influence of a stimulus to the muscles of voluntary motion. As these muscles obey stimuli applied to only a part of the brain, or spinal cord, where the nerve supplying a muscle originates, if the impression on this part be not sufficiently strong to produce a muscular movement, it cannot be assisted by any other part of the brain or spinal cord. Thus, it was found by Dr. Philip, "that a blow which affects the brain generally, without materially injuring it, produces comparatively little effect on the muscles of voluntary motion, because no one part of the brain suffers greatly; but it produces a great effect on the heart, because this organ feels the *sum of all the impressions.* (And so of the stomach, liver, intestines, &c.) The nervous system, therefore, may be so far exhausted (or affected) as not to admit of the vivid impressions necessary to excite the muscles of voluntary motion, and yet capable of those which influence the heart," blood-vessels, &c. This is strikingly seen in apoplectic affections.

The philosophy of this subject is farther explained in the following luminous manner by Dr. Philip: "Here," he says, "the question arises, by what means is the one set of organs (that is, the heart, stomach, &c.) subjected to the influence of *every part* of the brain and spinal marrow, while others are influenced by only small parts of those nervous centres? In these latter instances, we see directly proceeding from those small parts the nerves of the parts influenced. In the former instances, we do not see, in any case, nerves going directly from all parts of these organs to the parts influenced; but we always see this part receiving nerves from a chain of ganglions, to which nerves from all parts of the brain and spinal marrow are sent. It is therefore evident, from direct experiment, that the nerves issuing from the ganglions convey to the parts, to which they send nerves, the influence of all the nerves which terminate in these bodies."

By the same philosophy, so clearly founded in nature, we readily interpret the vast extent of influences which may be propagated from the stomach, or from any part in animal life, by morbific and remedial agents, through impressions transmitted to the brain and spinal cord by way of the ganglionic system; while, also, all parts of the nervous

centres may be influenced in their organic condition by impressions upon any distant part (§ 230). This application, too, of the foregoing philosophy is divested of prejudice, since it was not contemplated by the experimenter.

487, *gg*. "The following case, related by the distinguished Dr. Parry, on the arterial pulse, might alone be regarded as proving the existence of two sets of nerves in the extremities; the one supplying the muscles of voluntary motion, the other the powers supporting the circulation, and strikingly illustrates what has been said on this subject. 'I have seen,' says Parry, 'a *total loss of pulse* in one arm with coldness, but *complete power of motion* in that part; while the other arm was warm, and possessed a perfectly good pulse, but had lost all power of voluntary motion'" (§ 399).

487, *h*. We may now readily perceive, from the vast difference in the results between the influence of the nervous power upon animal and organic life, how the muscular power, or *strength*, as it is usually called, may be excessively prostrated at the invasion of disease, while organic actions may be as greatly increased, or if depressed, they may be so modified as to require the application of remedies from which we might shrink if we regarded alone the prostration of the voluntary muscles. It is an ignorance of the principle which operates in these cases (as in the vast range of congestive fevers), and reasoning from the prostration of muscular power to a supposed analogous state of the great powers of life, and thus mistaking mere prostration of animal life for absolute "*debility*" of the organic viscera, that has led so extensively to the administration of stimulants and tonics, where bloodletting and analogous agents are most imperatively required. The mind, too, is inoperative in all these conditions, and the voluntary muscles languid, in consequence; and the very failure of the will to rouse them into action, where drowsiness has contributed its effect, has been often regarded as an evidence of that "*debility*" which calls for the "stimulant plan of treatment" (§ 473, 961, &c.).

It cannot, therefore, be too strongly enforced, that in all cases of sudden prostration at the invasion of fever, the nervous power has a principal agency in the phenomenon,—that its influences on animal and organic life are widely different,—that it simply fails to stimulate the voluntary muscles, and hence the greater amount of apparent "*debility;*" while in relation to the organic processes, it has been so modified as not only to exalt, or perhaps depress, the forces of life, but to alter profoundly their very nature (§ 476 *c*, 500 *h*).

There is nothing in the whole range of medical philosophy so practically important as these considerations (§ 569, 961, 967). It is a subject, however, which requires thought for its proper understanding, as well as a comprehensive view of profound laws in physiology. It is therefore repulsive to the many, who will rather rest upon the simple chemical and physical hypotheses, than contemplate Nature in her dignified and rational aspects. The charm of simplicity which hung around the celebrated theory of John Brown encircles, also, the humoral and other chemical hypotheses, and adds its fatal delusion to those prevailing doctrines.

488. An important remark is made by Philip, at the close of his experiments relative to the functions of the heart, blood-vessels, and voluntary muscles, and their essential independence of the nervous

system, which goes to corroborate the conclusions I have drawn as to the agency of the nervous power in the healthy and morbid processes, of its modifications according to the nature of the agents by which it is developed, &c.; and this the more so, as Dr. Philip had formed no such inferences, but regarded the nervous power as the galvanic fluid, stimulating the various parts of the system, and a mere chemical agent in the formation of the secretions. I refer particularly to the clause in italics.

"It not only appears," says Dr. Philip, "from the experiments which I have laid before the reader, that the power of the heart and vessels of circulation is independent of the nervous system, but that that of the muscles of voluntary motion is so likewise, and that these, *like the former, are only subjected to this system* IN THE SAME WAY *in which they are subjected to every other agent that is capable of exciting them.* Thus we find, that all the *moving powers* of the animal body, as far as we have hitherto traced them, are independent of the nervous system, but that this system is equally capable of *acting as a stimulus to them, although in different ways,* whether they are subject to the influence of the will or not" (§ 133–162, 188½–190, 222–233, 205, 206, 208, 209, 256, 476 *c*, 484, 500 *h*).

488½. I shall now advert, once more, to the remarkable distinction between the operations of the nervous power as manifested in animal and organic life (§ 96–110). In animal life, the nervous power constantly influences, in a sensible manner, all the involuntary actions, and is obedient to the will in respect to all the voluntary muscles (§ 245, 476 *c*, 500 *h*). Its intensity of action, and consequent manifestations, depend upon the force or intensity of the exciting causes. For these habitual functions of the nervous power the cerebro-spinal system is specifically provided. Coming to the organs of organic life, we find them supplied with a system of nerves remarkably different from the cerebro-spinal, and a corresponding difference in the laws of nervous influence. Every fact is here demonstrative that the actions of organic life are essentially independent not only of the influences of the brain and spinal cord, but of the ganglionic system itself; and confirm the suggestion which is made by the distribution and arrangement of the sympathetic nerve, that its great final cause is to preserve a harmonious action among the organs of organic life.

But, there is this coincidence in the actions of the two lives; namely, the power which generates motion, both in animal and organic life, is independent of the nervous system (§ 205–215); but the nervous power is equally capable of influencing its operation, though in different modes (§ 226–233, 454–461½, 500).

489. The question is investigated by Philip, "*whether the power of secretion is also independent of, though influenced by, the nervous system.*"

The subject is fully settled by experiment; though the analogies supplied by the vegetable kingdom are amply conclusive of the essential independence of the function of secretion, and its *products*, of the nervous system in animals.

From Philip's, and the experiments of others, it results, for example, that a division of the pneumogastric nerves either destroys or greatly impairs the digestion of food. But, says Philip, "it deserves notice, that the food, in such cases, is found covered with apparently

the same semi-fluid which we find covering the food in a healthy stomach;" and "the lungs are found *distended* with a frothy fluid, which fills the bronchi and air-cells."

It follows, therefore, that the function of secretion, and its *products*, are independent of the nervous system, but may be more or less influenced through that system. Such is the inevitable conclusion from the experiments themselves; and yet their author was led into an important error by his hypothesis of the identity of the nervous power and galvanism (§ 493).

5th. *On the Principle on which the Action of the Alimentary Canal depends.*

490. Philip destroyed separately, and simultaneously, the brain and spinal cord, and, in other instances, removed both at the same time. In all the cases, "the motion of the stomach and intestines continued till the parts became cold, so that when the intestines exposed to the air have lost their power, that of those beneath still remains." "It appears from these experiments, that the power of the stomach and intestines, like that of the heart and blood-vessels, resides in themselves, and is wholly independent of any influence derived from the nervous system."

But, a better experiment, not only in respect to the intestinal canal, but the heart also, as it relates to the foregoing independence, consists in removing both from the body; as indicated in § 476½, *c*.

6th. *On the Relation which the Alimentary Canal and Lungs bear to the Nervous System.*

491. Direct experiments, as in the foregoing cases, by agents applied to the brain and spinal cord, show that the stomach, intestines, and lungs, may be influenced through the nervous centres. "It often appeared," says Philip, "that spirit of wine applied to the brain and spinal marrow increased the motion of the canal;" that, "the stomach, like the heart, is capable of being influenced by every part of the brain and spinal marrow" (§ 487, *g*). For these important investigations the reader is referred to the work itself.

Review of the Inferences from the preceding Experiments.

492. The following inferences are made by Dr. Philip in relation to his various experiments, and it will be seen that they are without objection, and may be applied to the most important problems in physiology and practical medicine:

1. "That the vessels of circulation possess a power capable of supporting a certain motion of the blood independently of the heart.

2. "That the power both of the heart and vessels of circulation is independent of the brain and spinal marrow.

3. "That the nervous influence is capable of acting as a stimulus both to the heart and vessels of circulation.

4. "That the nervous influence is capable of acting as a sedative both to the heart and vessels of circulation, even to such a degree as to destroy their power.

5. "That the effect of the sedative is not the result of an excess of stimulus, but, like excitement, the direct operation of the agent.

6. "That the power of the muscles of voluntary motion is independ-

ent of the nervous system, and that their relation to this system is of the same nature with that of the heart and vessels of circulation, the nervous power influencing them in no other way than as other stimuli and sedatives do.

7. "That the cause of the muscles of voluntary and involuntary motion appearing, at first view, to differ essentially in their nature, is their being excited by stimuli essentially different; the former being always excited by the nervous influence, the latter, though occasionally excited by this influence, in all their usual functions obeying other stimuli.

8. "That the brain and spinal marrow act, each of them, directly on the heart, as well as on the muscles of voluntary motion.

9. "That the laws which regulate the effects of stimuli applied to the brain and spinal marrow, or the heart and muscles of voluntary motion, are different.

[This affirmation can be made only of certain differences in the modes in which vital agents affect the heart and voluntary muscles. A common principle is at the foundation of the whole (§ 500, *h*).]

10. "That mechanical stimuli applied to the brain and spinal marrow are better fitted to excite the muscles of voluntary motion, and chemical stimuli the heart.

11. "That the heart obeys a much less powerful stimulus applied to the brain and spinal marrow than the muscles of voluntary motion do.

12. "That stimuli applied to the brain and spinal marrow excite irregular action in the muscles of voluntary motion.

13. "That no stimulus applied to the brain and spinal marrow excites irregular action in the heart or vessels of circulation, nor is their action rendered irregular by sedatives, unless a blow, which crushes a considerable part of the brain or spinal marrow, be regarded as a sedative.

14. "That the excitement of the muscles of voluntary motion takes place chiefly at the moment at which the stimulus is applied to the brain and spinal marrow, while that of the heart may generally be perceived as long as the stimulus is applied.

15. "That after all stimuli applied to the brain and spinal marrow fail to excite the muscles of voluntary motion, both mechanical and chemical stimuli, so applied, still excite the heart.

16. "That the vessels of secretion, like the vessels of circulation, are independent of, but influenced by, the nervous system.

17. "That the peristaltic motion of the stomach and intestines is independent of the nervous system.

18. "That their motion is capable of being influenced through the nervous system.

19. "That the stomach and lungs, like the sanguiferous system, are influenced by every part of the brain and spinal marrow.

20. "That the proof of the vessels possessing a principle of motion independent of their elasticity, which bears the same relation to the nervous system as the excitability of the heart, not only as far as respects the kind of influence which they derive from that system, and the way in which it is supplied to them, but also as far as respects the purposes for which it seems to be bestowed on them, affords a strong argument for believing that this power is of the same nature with that of the heart."

493, *a*. It is remarkable that the sagacious mind of Dr. Philip should have fallen into the error of deducing from his experiments the identity of galvanism and the nervous power, and the dependence of the secreted substances upon that principle. "The vessels of secretion," he says, "*only convey the fluids to be operated upon by the nervous influence*." Here the "influence" is regarded strictly as a chemical agent. But, at the same time, he unavoidably concludes that "the *vessels* of secretion, like the vessels of circulation, are independent of, but influenced by, the nervous system;" galvanism, however, being the supposed agent in all the cases.* And yet Dr. Philip, through the light of galvanism, is led to the contradictory statement, "that, although the powers of circulation are independent of the nervous system, those of secretion are very far from being so." And, as to the products themselves, had he, or had others subsequently, considered the simplicity of the laws of Nature, and the remarkable Unity of Design which prevails in the fundamental constitution of all organic beings, from the humblest plant up to man, it never could have been entertained that the powers which circulate the blood, like those of the sap in the vegetable kingdom, and govern the action of the secreting vessels, are independent of the nervous system, and yet that the formation of the secreted products is dependent on the nerves. There is nowhere in Nature so great a violation of consistency; while, also, secretion is just as much a function of vegetables as of animals (§ 638). I am not, however, unmindful of the indisposition to predicate of final causes, or of any obvious Design, the intentions to be fulfilled, or any principle in philosophy which may be involved in the Plans of the Creator (§ 350$\frac{3}{4}$, *kk*). But, since every thing in nature emanates from its fundamental constitution, I can have little doubt that we shall be gradually led to recognize the connection of philosophy with the Works of its Author, and to acknowledge that in all philosophy we are employed in seeking out the Institutions which He spoke into existence, and in doing which we may derive much assistance from going beyond the immediate phenomena, and thus, also, render philosophy and natural Religion, and of course, therefore, Revelation, subservient to each other.

493, *b*. Dr. Philip also adopted the error, which had been long propagated, of regarding the brain as a mere galvanic battery, and the nervous power as identical with the galvanic fluid, and thus gave a farther impulse to those chemical hypotheses of life which have so extensively usurped the place of medical philosophy, was compelled to embrace these hypotheses himself, and thus to advance the very errors which have contributed to obscure the light which his experiments reflect upon every department of medicine (§ 350, nos. 5, 18–20, 42). It was his misfortune to have come upon the stage just at the overthrow of that philosophy which had been so highly advanced by Hunter, Bichat, Cullen, and their compeers, and the revival of the exploded physical and chemical doctrines of life, and of the humoral pathology.

493, *c*. Again, having assumed that "the brain and spinal marrow are necessary to the function of secretion," Philip raises an objection which he foresaw would prevail. This objection consists in the ma-

* See *Medical and Physiological Commentaries*, vol. i., p. 52–68, 107–119, where the subject of galvanism is fully examined.

turity of the fœtus without brain and spinal cord; and to defend the chemical hypothesis, and the assumed identity of the nervous power and galvanism, he endeavors to avoid the obstacle by assuming that, when the brain and spinal marrow are absent, the *uterus* performs the functions of those parts to the fœtus; that is, it acts exactly as the brain and spinal cord in supplying the nervous power. But this conjecture, independently of the absence of every fact, is contradicted by the total want of the requisite analogy between these two systems of organs. To give greater plausibility to the hypothesis, Philip remarks, that "no writer has before attempted to explain the difficulty."

In the mean time, however, Philip very justly, however inconsistently, objects to the assumption which has been made by others, that secretion, and consequently the growth of the fœtus without brain and spinal cord, is supported by the nerves, and says, rightly, that "it is not only a gratuitous supposition, but opposed by almost every fact on the subject relating to the perfect animal" (§ 63–81, 257, 409 *k*, 455, &c., 516, no. 8). Yet is there greater plausibility in this doctrine than in the uterine philosophy; since there is an appropriate analogy between the nerves and the brain and spinal cord.

493, *d*. We may not, in justice to a subject so important as medical philosophy, disregard the influences that may be exerted by any error proceeding from one who has contributed so largely to that philosophy as Dr. Philip. I shall therefore say, and with a view, also, to my remarks on the physical theories of inflammation, that this eminent man, to advance his chemical theory of secretion, falls into a common error now taught by the schools. Thus: "It is not to be overlooked," he says, "that the vessels convey the fluids to be operated upon by the extreme parts of the nervous system, in a peculiar way. By the diminished capacities of the capillary vessels, *the blood is divided as by a fine strainer*, some of its parts being *too gross* to enter the smaller vessels." "This," he adds, "is necessary to prepare the blood for the due action of the nervous influence" (§ 188, &c., 399, 408–411, 748).

Now, what can be more inadmissible than the comparison of the living, organized vessels, whose *actions* are *proved* by Dr. Philip to be influenced by the nervous power, to a set of dead, inorganic tubes; what more adverse to our natural conceptions of life; what more strongly opposed by facts than the assumption that one part of a continuous living vessel acts as a "strainer" of the blood from another part having a vital function?

In consequence of the foregoing physiological doctrine, Dr. Philip is compelled to give in his adhesion to the present physical doctrines of inflammation, as set forth in the sequel (§ 748, &c.). This, too, may be regarded as a principal reason why his experiments have not been applied to the philosophy of disease and therapeutics (§ 453, *a*).

Philip thus lost the opportunity of applying his observations to any useful or practical purpose. Nevertheless, his very misapprehension of their true import, and his diversion from the path of Nature, impart to them that inestimable value which belongs to the conviction that the facts lead only to the truth where they were intended for the support of error (§ $5\frac{1}{4}$, $188\frac{1}{2}$ *d*).

494, *a*. In concluding this important subject, I shall bring up the late experiments by Van Deen, Stilling, Budge, and others, by which those of Philip have been again confirmed, and the results extended.

It will be seen that they have a very specific bearing upon the doctrines of humoralism (§ 819, &c.), and upon the modus operandi of morbific and remedial agents (§ 893, &c.). It might have been useful to have stated them in immediate connection with either of those subjects; but they should form a part of the combined force which marches in advance upon the regular plan of organization.

494, *b*. *Exp.*—After Fontana had made more than 6000 experiments, in which he employed more than 3000 vipers, and caused to be bitten more than 4000 animals, to extort the conclusion that the poison of the viper kills all animals by acting upon the blood, the whole of those 6000 experiments were overturned by a single one by Girtanner; showing that the poison will kill frogs entirely deprived of blood in as short a time as it kills those which have not lost their blood.

The conclusive nature of Girtanner's experiment has been entirely disregarded by subsequent humoralists, whether as it respects the operation of morbific, or of remedial agents; or more probably the experiment is unknown to most, or forgotten.

The late experiments by Van Deen and Stilling are of the same nature as Girtanner's, and again call upon physiologists to return upon the path of nature. Of these experiments I shall present one or two only, as being sufficient for every intelligible purpose connected with my subject.

It should be premised, that when all the viscera, the heart, blood-vessels, &c., are removed from frogs, so that nothing remains but bones, muscle, and nerves (as was done in Girtanner's experiment), the animal will hop about for half an hour, and appear in all respects as natural as in its perfect state. (See, also, Spallanzani, § 441, *f.*)

494, *c*. *Exp.*—The frogs being thus completely eviscerated, and all vascular connections with the spinal cord destroyed, Van Deen divided the cord through the third vertebra, and then introduced within the mouth a drop or two of the acetate of strychnia. In a few minutes, the parts above the section of the cord were affected with spasm, while those below were unaffected.

494, *d*. *Exp.*—Again, Stilling also eviscerated many frogs, after the foregoing manner, and, on applying acetic acid to the *skin*, as late as half an hour after the evisceration, he excited reflex movements.

494, *dd*. Observe, too, how an important modification of these experiments goes to the same conclusion. Stilling exposed the spinal cord of a frog thus completely eviscerated, and touched it with a solution of the acetate of strychnia, which gave rise to the same general tetanus as when strychnia was applied to the mouth or skin. Even an isolated portion of the cord would give rise to spasm in parts supplied by that portion, on being touched with the solution. From this fact, Stilling draws the conclusion, that if the cord be divided in numerous places, each portion is a nervous system in itself, and capable of transmitting influences through communicating motor nerves, independently of the brain, or of other parts of the cord (§ 459, 828).

In the foregoing experiments, which are only examples of a great variety by the same physiologists, we have another full confirmation of the preceding ones by Philip, with the additional advantage of other agents to obtain the corresponding results. Nor will the reader fail to observe that the same remarkable phenomena occurred in the eviscerated frogs when acetic acid was applied to the *skin* as when the

acetate of strychnia was applied within the mouth, as in Van Deen's experiment (§ 494, *c*). This is an important element in interpreting the sympathetic influences of remedial and morbific agents when applied to the surface of the body.

It will be also seen that the foregoing experiments upon the skin coincide with those by Alston, made in 1733 (§ 484).

These observations put at rest Müller's interpretation of the action of prussic acid in producing instantaneous death when a drop is applied to the tongue, and which has been extensively employed by the humoralists to preserve the purity of their doctrines. The more we consider the profound familiarity of the Berlin Philosopher with the laws of the physiological state of the nervous system, and his full recognition of the vital principle and all its attributes, the more are we surprised at his universal doctrine of physical absorption, and his extreme defense of the humoral pathology, as evinced in the following extract from his *Elements of Physiology*. Thus:

"The rapid effects of prussic acid can only be explained by its possessing great volatility and power of expansion, by which it is enabled to diffuse itself *through the blood* more rapidly *than that fluid circulates*, to permeate the animal tissues very quickly, and in a manner independent of its distribution by means of the blood," &c. And yet, in the same paragraph he states that nux vomica, which is not volatile, will produce the same speedy death (§ 498 *c*, 826 *d*, 827 *d*. Also, *Med. and Phys. Comm.*, vol. i., p. 565, 569, text and notes).

And again, says Müller, "My experiments, as well as many others, instituted by well-known physiologists, prove that, before narcotic poisons can exert their general effects on the nervous system, they *must enter the circulation*."

Müller's doctrine, I may also say, that the absorbent vessels have no open terminations, and his physiological construction of their function, leads him to the propagation of errors which have vitiated the whole fabric of physiology and medicine. The doctrine may be summarily expressed in the following language of its author. Thus:

"The primary phenomenon of the immediate absorption of substances in solution into the blood is the *permeation of animal tissues* by the fluids. The property of permeation by fluids possessed by tissues, even after death, depends upon their *invisible* porosity, and is termed *imbibition*." Some of the consequences may be seen in sections 289, 291, 350, no. 24, 350½ *n*, 514½ *a*.

494, *e*. What I have now stated of the experiments by Van Deen and Stilling relates particularly to influences exerted in animal life, though, like Philip, they have corresponding experiments in organic life. These it would be superfluous to repeat, especially as some of the foregoing involve a complex agency of the ganglionic nerve (§ 516, no. 13).

Budge, however, has lately made a multitude of experiments with a view to the physiological relations of the cerebro-spinal and sympathetic systems. There is novelty about them, and they go far in sustaining my philosophy of remote sympathy, and in all its wonderful details, and in corroborating that philosophy which I originally set forth in the "Commentaries" as to the *modus operandi* of morbific and remedial agents.

It will be observed, also, of Budge's experiments, that they are anal-

ogous to those which have been made by introducing different agents into the stomach capable of affecting the great nervous centres, and thus deducing the special influences of certain functions of the brain upon distant parts. The experiments in which the nervous centres were irritated should be, particularly, compared with those by Philip, in which he employed alcohol and tobacco. Thus:

Exp.—The heart of a frog having ceased to beat but once in fourteen seconds, the anterior cords of the cervical portion of the spinal marrow and of the medulla oblongata were irritated, when the heart beat once in three seconds. On first irritating the posterior cords, no effect ensued. In other experiments the action of the heart was restored, after it had ceased to beat, by irritating the anterior cords of the medulla oblongata with a needle, or by caustic potash. So, also, irritation of the corpus callosum reproduced the actions of the heart. Irritation of the cerebellum restored the movements of the stomach, and brought on vigorous contractions of the colon and urinary bladder. The last two organs were also affected in the same way by irritating the anterior part of the spinal cord.

The young student should be careful not to confound these movements with those of continuous sympathy, as exhibited in § 498, &c. The foregoing are effected by a determination of the nervous power upon the organic properties of the several parts (§ 222, &c.).

IV. OF THE VARIETIES OR KINDS OF SYMPATHY.

495. We have hitherto seen that the several properties of life are distinguished by remarkable modifications, and that in some of the instances the varieties are so great as to amount to distinctions in kind (§ 133–163, 175, 177, 185, 190, 191, 197, 200, 215, 217, 219, 220, 226–230). And so, also, more or less, of the functions. The same rule obtains as to sympathy, this function having been divided by Mr. Hunter into *remote*, *contiguous*, and *continuous* (§ 452, &c.).

496. Remote sympathy is the principal condition of the function. Its office is the transmission of impressions, whether natural, morbific, or remedial, to and from parts separate from each other, or different parts of a compound organ, or through which the nervous influence is determined on parts which receive the primary impressions, or when that influence proceeds from direct impressions, physical or moral, upon the cerebro-spinal system itself (§ 230). In the last case, the rationale of the function is very analogous to that of voluntary motion (§ 233).

497. Contiguous sympathy is probably a modification only of remote sympathy. Its peculiarity is shown by the effects of blisters, leeches, and various other external applications, in relieving internal disease, in proportion as they are applied most immediately over the internal part. Doubtless the centre of this kind of sympathy, or where the nervous power is excited and reflected, is often some part of the ganglionic system, or perhaps some plexus of nerves, or some parts of the sympathetic nerve itself (§ 473, no. 2, *c*, *d*; § 474, no. 5, 520). It should be observed, however, in these cases, that remote sympathy, in its clear acceptation, is brought into action.

The apparent effects of contiguous sympathy, however, may be sometimes explained, especially in consecutive morbid processes, by

the irritation from enlarged vessels, or from effusions of coagulable lymph, or dryness of surface, &c., as in pleurisy and ophthalmia.

498, *a.* Continuous sympathy is independent of the nerves, and belongs to plants as well as animals. It is most strongly pronounced when unusual stimuli operate, and it always occurs in the tissue, or another continuous with it, upon which the primary impression is made. I would prefer calling it *continuous influence.*

498, *b.* Its mode of propagation consists in the condition of a particular part of a tissue, where some impression is made upon the organic properties, being extended to other parts continuous with it, in uninterrupted succession; though the changes may be much more intense in some parts of the tissue than in others (§ 516, no. 2).

498, *c.* In the natural condition of the being, the operation of this principle is strikingly manifested in the various sensible motions of plants. For example,

"To excite the motion of the leaflets and petiole of the mimosa, it is not necessary that either the intumescence itself, or even the leaves, should be touched. The stimulus may be applied to a more or less distant part. Even the roots transmit the excitation to the leaves. M. Dutrochet moistened a small portion of the roots of the mimosa with sulphuric acid, and, *before there was time for the absorption of the acid* to have taken place, the leaves became folded" (§ 289).—MULLER'S *Physiology.*

And yet we learn from able physiologists, that the whole connected movements of plants, in their circulation, and other organic actions, depend upon purely physical causes (§ 257, 261, 289–291, 293, 294, 303, 304).

498, *d.* In the animal body, I have shown that the contractions and dilatations of the veins are greatly owing to continuous sympathy, the immediate exciting causes consisting in the existing state of the communicating arteries and the variable quantities of transmitted blood. Here, too, as in the circulation of the sap, the propagation of the continuous sympathy or continuous influence is exceedingly rapid, and results in a corresponding development of motion (§ 794, 795).

498, *e.* Again, as exemplifying the existence of continuous sympathy, and its independence of the nervous system, take another fact from the animal kingdom. Thus:

In the heart of many animals, "cut out and left undisturbed until the frequency of its beats shall have so far diminished that considerable intervals intervene between the contractions (or if it have entirely ceased to beat), mechanical irritation by means of a needle excites a contraction which cannot be confounded with the *regular* beats; and, at whatever part the irritation be applied, the reaction is the same as if the whole heart had been irritated; that is to say, there ensues a contraction not at one point only, but of the whole organ."—MULLER'S *Physiology.*

Bichat says of the foregoing experiment, if the action of the heart be allowed to cease entirely, and the organ be then pricked, it will not only begin to act again, but that a dilatation of the cavities will sometimes take place first. The action, too, may not begin till some seconds after the part is irritated (§ 189, 494 *e*, 516).

498, *f.* Continuous sympathy is an important element in the physiology of disease and of therapeutics. This is conspicuously seen in

the propagation of inflammation from a central point. In a therapeutical sense, it is seen in the relief of hepatic congestions by leeches applied to the anus; when, besides the direct effect from loss of blood, the peculiar vital impression which is made upon the organic properties of the mucous tissue of the rectum by this mode of abstracting blood is propagated progressively along the whole tract of the membrane up to the duct of the liver, along which it is extended to the organ itself, whose secretion is thus, in part, increased, and the organ otherwise brought under a salutary influence. But, it is also true, that the impression which is made upon the intestinal mucous membrane is propagated to the brain and spinal cord by way of the sympathetic nerve, from whence the nervous power is reflected upon the liver, skin, &c., with a salutary effect, through the motor fibres of the same nerve; and thus remote sympathy is simultaneously brought into operation (§ 523, no. 6. Also, *Medical and Physiological Commentaries*, vol. i., p. 135, &c.).

498, *g*. The continuous impression, in the foregoing case, upon the intestinal mucous membrane, is equivalent, in principle, to that which is produced by cathartics; so that remote sympathetic influences may be propagated from all parts of the canal, as well as from the verge of the anus. Exactly the same order of influences springs from enemas and suppositories, whether of a sedative or purgative nature (§ 526). In all the cases, the functions of the liver are reached through the instrumentality of the intestinal mucous tissue, just as mechanical irritations of the conjunctiva, or of the membrane of the mouth, affect the lachrymal, or the salivary glands (§ 923).

499, *a*. The brain and spinal cord, therefore, are the great sources of true sympathy; but the ganglionic system has an important participation, and probably supplies, in its ganglia, centres of sympathy. Remote sympathy appears sometimes to spring from these ganglionic centres, and contiguous sympathy more commonly (§ 455, 458, 459, 490, 493, 507, 520).

499, *b*. It is also evident, that the most essential element in sympathy is the nervous power. It is this power which brings about all the ultimate and important results. It is excited by all kinds of physical and moral causes, and variously modified in its nature and effects, according to the nature of the exciting causes (§ 222–233).

500, *a*. Remote sympathy depends, primarily, upon impressions made upon the sensibility of parts distant from the nervous centres, or directly upon the centres themselves. In one case the function is associated with sympathetic sensation, in the other it is not (§ 445).

500, *b*. When made upon distant parts, the impression is transmitted to the nervous centres through nerves of sensation or the sensitive fibres of compound nerves, and brings the nervous power in those centres into unusual operation, from which this power is reflected through nerves of motion, or the motor fibres of compound nerves, upon the irritability of other parts, or of the part which sustained the primary impression, and thus gives rise to those various results which are the prominent phenomena in this complex function (§ 455 *d*, 464–471).

500, *c*. The ordinary results of remote sympathy will follow impressions made directly upon the nervous centres, and, indeed, upon the trunks of nerves (§ 474 *b*, 507). These impressions may be made

upon the brain and spinal cord, and by all kinds of physical agents, and by the mind and its passions. The physical and the moral are alike operative. They rouse the nervous power, and modify it according to the nature of the cause, as in the former case (*b*); when it is transmitted to other parts, as in the more complex process (§ 222–233, 476–492). If the brain or spinal cord be irritated by the direct application of alcohol, it will increase the action of the heart and blood-vessels; or, on the contrary, their action will be diminished by the application of tobacco, opium, &c. (§ 476, &c.). And just so with the different passions, and emotions. Joy produces a lively action of the heart and all the cutaneous vessels; anger a more violent state of general arterial excitement; shame suffuses the face in one way, and love in another; fear subdues the action of the heart and capillaries, induces palpitation, covers the body with a cold sweat, and leads to unwonted micturition; jealousy is attended by other remarkable results in organic life; grief undermines digestion, &c. Disgusting sights, like emetics, produce vomiting, as will even their recollection. These cases are all coincident with those in which organic actions are influenced by irritating the brain or spinal cord mechanically, and involve exactly the same essential principle which is concerned in the most complex processes of remote sympathy (§ 476, &c., 508).

500, *d*. The operation of the will, in producing voluntary motion, follows the same rule as that of the passions. Each is equally a cause of development of the nervous power. The will merely acts as a stimulus to the brain, by which the nervous power is developed and transmitted to the voluntary muscles, where, by its operation upon mobility, through irritability, voluntary motion is produced (§ 215, 226, 233, 243–246, 258, 467, 476 *c*).

"Irritability," says the able Macbride, "is to be held as a requisite foundation for the power of voluntary motion; for, if we may be allowed to make a comparison, the soul would be no more capable of moving any particular muscle, or set of muscles, if their fibres, in general, had not the property of irritability, than a musician would be capable of bringing music out of a violin, if its strings were not endowed with the property of elasticity" (§ 189, 206).

And this shows, us, also, the final cause of the exquisite endowment of all muscles in organic and animal life with irritability, while they possess only a low degree of sensibility (§ 193, 206).

We thus see, too, another remarkable exemplification of the manner in which the nervous power is so excited by the nature of the exciting cause that it shall give rise to voluntary motion. That the will acts as a stimulus, only, to the brain, and that voluntary motion is immediately determined by the nervous power, is manifest from the coincidence between voluntary motion and the spasmodic affections of the same muscles that arise from irritations of the gums or of the intestinal canal. The same is shown by the spasmodic actions induced by nux vomica, in paralytic affections; which also illustrates the distinction between irritability and sensibility, and shows that motion does not depend upon the nervous system (§ 188, 193, 195, 206, 208) In this case, sensibility may be very obtuse in the affected limb, while the agent will exert a greater spasmodic effect on the paralyzed than on the sound muscles. This greater effect is owing to the morbid

development of irritability. And what farther illustrates the philosophy as to the action of the nervous power upon irritability in rousing paralyzed muscles, is the opposite effect of conia; for, in this case, conia paralyzes the muscles without impairing sensibility (§ 487, *gg*).

In all these cases of spasmodic action, the irritations are propagated upon the cerebro-spinal axis, and prove an exciting cause of the nervous power; in the case of the will the irritation is direct, in its analogous function of voluntary motion. And what shows, in the case of the will, that it is the nervous power, transmitted to the irritability of the voluntary muscles, which is the immediate exciting cause of voluntary motion, is the manifest fact that this power is the immediate exciting cause of the analogous spasmodic movements.

"We know the peculiar office of the brain," says Philip, "by observing what functions are lost by its removal; the sensorial functions. The nervous, then, obeys the sensorial system, in the same way in which the muscular obeys the nervous system; but, as the muscular power has an existence independent of the nervous, so has the nervous an existence independent of the sensorial power."

500, *e.* Motion is produced in muscles that are partly voluntary and partly involuntary (as those of respiration), through the principles now stated; and the modus operandi of their involuntary movements also illustrates fully the philosophy of voluntary motion. Thus, in the involuntary act of respiration, some peculiar impression upon the lungs, arising, perhaps, from want of air, is the cause of that development and transmission of the nervous power to the respiratory muscles which induces an action precisely similar to that which is excited in the same muscles by an act of the will. The only apparent difference is, that, in the latter case, the nervous power is excited by the will, and not, as in the other case, by an impression transmitted to the brain from the pulmonary mucous membrane. It appears to be a common phenomenon, also, for the will to determine the nervous power upon the muscular coat of the intestines, just as it is, indirectly, by the irritation of a cathartic. This is evinced by the quickened peristaltic action when on the way to the temple of Cloicina. It is an example, too, in which the will is seen to exert a retarding as well as accelerating effect upon the intestines. The will has a still greater control over the muscular coat of the bladder, by which that organ is excited into action in the voluntary discharge of urine (§ 518). In the foregoing cases, however, the will commonly operates upon the organic muscles through its associate action upon the muscles of the abdomen and perinæum (§ 243, 519).

Here, also, is presented another fact in proof of the exactness of Design, another display of the special modifications of the properties of life, since it is here, if any where in organic life, that the will may be instrumental in carrying out the final causes of nature, while there is no reason to suppose that the will can exert an influence on any other part of the truly organic system (§ 72–74, 136, 181½ *d*, 199).

500, *ee.* The principle concerned in the foregoing voluntary and involuntary movements is the same as when an emetic operates; only, in this instance, the peculiar impression transmitted from the mucous tissue of the stomach, through the sensitive fibres of the pneumogastric nerve, modifies and directs the nervous power in a way peculiar to itself; so that besides taking its reflected course through the respiratory nerves of motion, and exciting convulsive instead of respiratory

movements, it falls upon various other parts, and may thus simultaneously induce copious perspiration, establish profuse secretions from the liver, intestines, &c., and break up croup, or pneumonia. Exactly the same law, also, is concerned when other remedial or morbific agents exert their effects upon parts remote from the direct seat of their operation.

500, *f*. The foregoing analogy between voluntary and spasmodic motions, and the mixed motions of respiration, extends to those movements which are generated or influenced by the passions, and between the whole there is a close analogy with the effects of all physical agents, and all morbid states, which influence organic actions through the medium of the nervous power, or sympathetically. The passions, also, like physical causes, produce involuntary movements in animal as well as organic life (§ 245, 844).

500, *g*. Different orders of nerves are, however, concerned in the transmission of impressions, more or less, according to the nature of the exciting causes. Thus, the nerves of volition are not those by which organic processes are influenced. Even in the voluntary muscles the irritability which is relative to their organic functions, as, also, sensibility, may be morbidly exalted, and yet the muscles be incapable of obeying the will, as often happens in paralysis (§ 487, *gg*). Again, other muscles, as those of respiration, are influenced both through the will and through remote sympathy. And while, in these respects, we can recognize no anatomical distinction, either in structure or relation of the parts, this inscrutable phenomenon is not less paradoxical than the agency I have ascribed to the nervous power in the production and cure of disease; while yet more astonishing is the institution of different orders of nerves, even of fibres in common nerves, for the transmission of impressions to the nervous centres, and from those centres to the circumference; and more surprising still is the reception and transmission of impressions from these centres (§ 189, 234, 236). And still more remarkable is the manner in which the will, the passions, and other exciting causes of motion, through the agency of the nervous power, pass over intermediate nerves, and elect, as their motor channel, those which are variously disconnected in their anatomical relations (§ 233¾). And here we may observe, farther, the analogy which subsists between the modus operandi of the will, and of physical agents, in developing motion (*d*). In all the cases, whether voluntary or involuntary, or mixed, as in respiration, the nervous power is roused and transmitted through motor nerves upon the irritability of all the parts that may be influenced (§ 188, 205). In the case of the will, and the passions, and of the immediate action of physical agents upon the nervous centres, the development of the nervous power is direct; but, when causes operate upon the nervous extremities, the nervous power is, of course, developed by impressions transmitted to the central parts.

500, *h*. Again, we learn from the foregoing considerations, that, since the will determines voluntary motion, but has no influence upon organic actions, with the exceptions stated (*e*); and since, on the contrary, the passions operate powerfully in organic, but imperfectly and only in an involuntary manner in animal life, and as judgment, perception, and reflection, exert no appreciable influences in either life, unless as morbific causes, or sometimes lessening the action of the

heart, while each are special exciting causes to the nervous system, it appears that all these causes or properties are distinct elements of the mental and instinctive principle; just as irritability, sensibility, mobility, &c., are distinct properties or elements of the vital principle (§ 175 *b*, 183, 188½ *d*, 234 *c*, 476 *c*).

500, *i*. Consider, again, how different agents applied to different parts will affect particular organs, remotely situated, in a very uniform manner, and, by common consent, through the nervous system; as the respiratory muscles, for example (§ 137). "The whole system of respiratory nerves can be excited to action by irritation of any part of the mucous membrane, from the mouth to the anus, from the nostrils to the lungs." This irritation may be established, and result in increased respiratory movements, by mechanical agents, as by tickling the fauces, and by many others through their intrinsic virtues, as tobacco applied to the nose. But, what is more remarkable, respiration may be also accelerated by impressions made upon particular parts of the surface of the body, as by tickling the feet; and again, by a strong light impinging on the retina; and yet, again, by hope and fear, by love and hatred. These examples embrace all the varieties that occur between the simple act of respiration and coughing, sneezing, and convulsive spasm. Again, another modified order of movements may be induced in the same muscles by agents of yet other virtues; as from the irritation of emetics. Mechanical irritations of the throat may also determine either coughing or vomiting; and here, as with the increased respiratory movements, certain irritations of the surface, as tobacco to the soles of the feet, will excite the respiratory muscles to the act of vomiting. In this last case, however, the irritation is first transmitted, sympathetically, to the mucous tissue of the stomach (§ 504), from whence it is returned to the nervous centres, and from thence reflected upon the respiratory muscles, the skin, &c. (§ 504, 514 *d*, *k*, *l*).

It will be thus seen, that these various agents, acting upon different parts, give rise to analogous or similar phenomena through the medium of the nervous power, but they involve a great variety of sensitive nerves, while the motor nerves are about the same in all the cases.

500, *j*. But, the foregoing complexity, which must find its solution in the attributes of the nervous power operating through its anatomical medium, is vastly increased by the coincident phenomena which may be determined by the will and by mental emotions. Thus, increased respiration, coughing, vomiting, &c., may be produced by an act of the will; grief occasions weeping and sighing; joy, laughter; yawning gives rise to yawning in another; disagreeable recollections produce vomiting, &c.

500, *k*. It is readily seen that a common philosophy must interpret all the foregoing effects. The fundamental cause is the same throughout. It is every where the influence of the nervous power; but what strange variety in the remote exciting causes! Nor is this all; for the same great and simple law obtains in all voluntary movements. Let us also especially remark the parallel which exists between the determination of the will upon particular muscles, according to its own choice, and thus constantly passing over, or isolating, various motor nerves, or, yet more remarkably, sending its influences through certain branches of a compound nerve and holding in passive subjection

all the rest, and of those agents which we have just seen to extend their influence specifically to the nerves of respiration, and those of a remedial or morbific nature which, like the will, elect and avoid the nerves without reference to order (§ 233¾, 492, no. 6). This astonishing phenomenon is perpetually in progress in health among all the organic viscera; and when we consider, also, how the well-trained juggler brings into simultaneous action almost every voluntary muscle, and each one in obedience to the foregoing law of elective influence, we shall readily comprehend how disease, and morbific and remedial agents, give to the nervous power the same complex direction, in organic life. But even more remarkable are the various intonations of voice, and especially such as form the melody of song. Each one, every variation, whatever the succession of change, is determined by an act of volition, rousing, and determining the nervous power, with all the rapidity and mutations of thought, with varying intensity, and incalculable changes of direction, and compounded in an endless manner, upon those muscles which are the immediate instruments of the vocal apparatus (§ 234 *e*, 473 *c*, no. 6, 526 *d*).

Following, in the foregoing manner, the path of nature, it is no difficult problem to understand how embarrassments in speech, as stammering, &c., should often depend upon morbid irritations of the cerebro-spinal axis, either of a direct nature, or from influences propagated from the digestive viscera, or from other parts. This philosophy, therefore, so opposed to the conclusions in surgery, enlightens us as to the temporary benefit, but the ultimate failure, in numerous cases, of dividing the sublingual muscle, and places the fallacious relief upon the true ground of a transient moral influence. These cases, therefore, should go into the hands of a profound physiologist.

500, *l*. In what has been said, therefore, of the various exciting causes of motion in the respiratory muscles, alone, we have a great element by which we readily attain the philosophy of those analogous examples in which morbific and remedial agents establish changes in organs where the nervous communications with the direct seat of the morbific or remedial action may be obscure, or far less manifest than with other parts on which no sympathetic influence is simultaneously exerted. And, coming also to those complex influences which hold the iris in complete obedience to the great final cause for which it was ordained, and many other equally demonstrable but intricate problems relative to the nerves, and those others which concern an unintermitting action of the nervous power in maintaining some of the most exact and obvious conditions of animal life, as seen in the permanent contraction of the sphincter muscles, we have a flood of light upon the subject which will not fail to dissipate every remaining obscurity, and establish forever an impregnable barrier against the chemical and physical doctrines and all the corruptions of the humoral pathology.

500, *m*. How shall we expound the seemingly paradoxical phenomenon of morbific or remedial agents transmitting their impressions through special nerves, in the foregoing irregular manner? We must look to the special relations of the operating causes to the vital properties of the parts remotely influenced, both in regard to the natural state of the properties and their acquired susceptibilities, and also as the operating causes may modify the nervous power. The fundamental principle is the same as where the will develops motion by deter-

mining the nervous power upon the animal muscles without reference to the order in which the nerves are distributed (*k*).

500, *n*. Contrasted with all this should now be stated the doctrine of the chemical school, as it comes applauded from the laboratory (§ 350¼).

The source of motion, then, with this school, voluntary and involuntary, is the same with that which Liebig assigns for thought, namely, a chemical change in the substance of the organ (§ 349, *e*). The motions of the heart, blood-vessels, intestines, &c., are said to be maintained by this incessant chemical process. If the will operate, chemical changes are at the foundation of the motion. The will is the decomposing cause, and chemical changes in the brain are the cause of the will, though "the Reformer" does not say what is the cause of those changes in the cerebral substance that give rise to the will and to other acts of intellection (§ 175 *c*, 349 *e*, 500 *h*).

It is presumable, however, that these acts are themselves the causes of the physical changes upon which they depend; just as it is said that the chemical forces are the cause of the vital force which is the cause of all the organic processes and results that depend upon and are produced by the chemical forces. That is the latest approved version (§ 4½ *d*, 349 *d*, 441 *e*, 447½ *f*). In this way, too, the chemist expounds the balance between waste and nutrition; and that the latter may sometimes gain upon the former, sleep has been ordained. In times of sleep, voluntary motion being suspended, there is less of the chemical waste, and therefore a chemical increase. That, also, is the approved philosophy of sleep. Here is a summary of the whole.

"Now, since in different individuals, according to the amount of force consumed in producing voluntary mechanical effects, unequal quantities of living tissue are wasted, there must occur, in every individual, unless the phenomena of motion are to cease entirely, a condition in which all voluntary motions are completely checked; in which, therefore, these occasion no waste. This condition is called *sleep*.

"Now, since the consumption of force for the involuntary motions continues in sleep, it is plain that a waste of matter also continues in that state; and if the original equilibrium is to be restored, we must suppose that, during sleep, an amount of force is accumulated *in the form of living tissue, exactly equal* to that which was consumed in voluntary and involuntary motion during the preceding waking period." —LIEBIG'S *Animal Chemistry*.

Here it is evident that the chemist was "nodding," from the oversight he has made of the coincidences presented by the nutrition of plants (§ 350, nos. 64–76). Nor is it the least remarkable part of the foregoing *rationale* of animal and organic functions, that the nerves are made the conductors of a force which is *every where* generated by chemical changes, and upon which force it is said the more sensible motions immediately depend, notwithstanding, also, these motions and those of an insensible nature are said to depend immediately and exclusively upon the chemical forces, as well as altogether upon the vital force (§ 350, 441 *e*).

But again, I ask the chemist for the primary cause of those chemical changes in which originate the acts of the mind, its passions, &c., and which call us from the sleeping to the waking state (175 *c*, 349 *e*,

350¾ *gg*). I ask the chemist, and the physical philosopher of life, to explain the mechanism and the laws of sympathy by the application of any principle in physics or chemistry. Let the chemist consider, that in every process of remote sympathy there are involved very diverse, yet very precise effects, and that he must have one species of chemical change for the transmission of impressions through the sensitive nerves to the nervous centres, another for the impressions exerted upon those centres, another for the reflection of the influences through the motor nerves, and yet another for the effects exerted at the ultimate destination of this amazing round of never-ending influences, as indispensable to the process of respiration; and coming to morbid states, there must be another series of chemical changes conforming, respectively, to the nature of every morbid influence and product (§ 188½ *d*, 464, 451 *f*, 649 *b*, 675).

Take any single attribute of the nervous system, and we shall find it as remarkably distinguished from all things else as is the mental principle. The power which appertains to that system, and presides over the whole life of animals, is just as unique in all its operations. The distinction alone, in various aspects, between the condition of the sensitive nerves, or the sensitive fibres of compound nerves, and those which are appropriate to the motor influence,—those which convey impressions to the central parts and those which transmit them to all parts of the organization, to the organic structure of the fountain itself,—those, I say, which serve to awaken the mind, or to stamp on the nervous centres, with all the precision of thought, an inconceivable variety of influences which are unceasingly in progress in every other part, but with no other appreciable result than the movements which follow in all the organic constitution, contrasted with the totally distinct prerogative of those nerves, and those fibres of compound nerves, which give rise to the distant movements and changes,—place, at an unutterable distance, all analogy with the recognized imponderable substances and with every other agent or power in the mineral kingdom (§ 451 *c*, 453). But, I would not so far speculate upon the nature of the nervous power as even to assume for it a place among the imponderables, which the physical philosopher, upon no better evidence, unhesitatingly avows as the condition of light, heat, and that more inscrutable substance, imponderable magnetism, which awakens no sensation, and produces no effect upon organic life. Least of all would I place the principle of life, or its element the nervous power, upon a par with the imponderables in their designated condition as material "fluids," nor claim for the latter a distinct individuality (§ 175, *bb*). The true physiologist attempts not problems which have no relation to principles and laws, and which divert philosophy from its practical uses. It is true, he argues the existence of the principle of life, its remarkable attributes, its contradistinction from all other agents, upon the ground of the philosopher in physics, that he may meet the obtruder with his own ratiocination. He tells him that his premises are the same, only more various, distinct in their nature, and more demonstrative. He points him to his "undulations" of light, the velocity of their movements, the prismatic analysis, its confirmation by life, his imponderable mystery which spans the globe, its co-operation with the electric fluid, their instant transmission of a disturbing cause to the ends of the earth, making the record at one

of its poles ere the impulse has ceased which began at the other (§ 175 *bb*, 188½ *d*, 234 *c*, *d*, *e*).

500, *o*. Let us now observe, summarily, the wonderful system of analogies which Nature has ordained among the vital stimuli, and learn from this, and from the same system of relationship which distinguishes other parts in the great chain of existences, that her laws are simple where the phenomena are various and complex, and that all her designs and operations are susceptible of reduction to a few general principles, which, when once known, illuminate the darkest labyrinth, and serve us instead of the voluminous facts which have been gradually accumulating for ages. One principle is a key to a thousand phenomena; and as new ones spring up, having analogies with such as are known, the principle comes to their ready interpretation.

In respect to the analogies among the vital stimuli, the mind, being connected with the body, and acting upon it both directly or through the nervous power, should naturally be one of them; and here we find it operating in peculiar ways upon the irritability both of organic and animal life,—first directly upon the brain, and then producing voluntary motion through the nervous power, or so affecting the organic states as to be a morbific or a curative agent. Just so with foreign agents. Irritate the brain and spasms will follow, while the same irritation goes to the recesses of organic life. The natural stimuli of life maintain the vital actions by exciting the vital properties. But, there are many foreign agents which are morbific, and these operate in the same way, only, at the same time, they alter the nature of the vital properties; and it is exactly in this way, also, that the mind and its passions produce disease. The impressions, however, in the former case, may be reflected from the nervous centres, while in the latter, they originate in those centres. Again, there are other foreign agents which aid in restoring the diseased properties and actions to a healthy state, and their principle of operation is exactly similar to that of the mind when this agent aids in the removal of disease.

Take next the blood, the natural vital stimulus of organic actions, which makes its impressions upon the same properties and in the same way as we have just seen of the mind and foreign agents. But, unlike the latter, it is a living agent, and calls into action the properties of life for the purpose of being itself acted upon, that it may be incorporated with the organized structure and receive the plenitude of those powers through which it becomes a part of the organized tissues, that this new formation may again generate the same fluid, and be acted upon, in its turn, by other blood. Its analogy, therefore, to the mental principle relates especially to its property as a vital agent. But, we find in the nervous power an agent of more extensive analogies with the blood, since this agent, like the blood, not only affects the organic properties and actions, but is also exquisitely susceptible of modifying influences, of changes in its nature, from the action of the mind and from external morbific and remedial agents,—acquiring even the very character, as an operating cause, which appertains to the agents, respectively, that may call it into action (§ 223–232). The range of analogies is, therefore, coextensive between the nervous power and all other vital agents (§ 74 *a*, 188½ *d*). And so of the semen in its action upon the organic properties of the ovum; infusing, also, not only a physical, but a moral constitution into the ovum. The

corporeal and mental attributes of both parents are, in consequence, blended together (§ 63, &c.).

Consider, finally, the hibernating animal, whose general modification of irritability (§ 191) is so constituted with a reference to preservation against low degrees of external temperature, that mechanical irritation, heat, and a variety of agents applied to the surface, shall so awaken the nervous influence that his temperature will suddenly rise from below the 40th degree of Fahrenheit up to its natural standard of 98°. But the curious fact attending this remarkable law of preservation is the same result from an intensity of cold that would otherwise destroy the animal (§ 441, *d*).

500, *p*. In respect to the subserviency of the brain to the operations of the mind, I will add in farther explanation of what I have said in section 241, that we have the best reasons for believing that the brain is especially designed for the subserviency of the will and perception, and has comparatively little connection with judgment, reflection, &c., and less with perception than with the will. Its great final cause, in respect to mind and instinct, is to serve as a medium of communication with the voluntary muscles, through the nervous power (§ 455, *a*). The will is, therefore, a stimulus to the brain, while this organ supplies, in consequence, the nervous power by which the voluntary muscles are brought into action.

In respect to perception, we discover the relation of the mind to the brain in another aspect, and, also, another analogy between the will and physical agents as vital stimuli. Through sensibility the brain is acted upon, and this impression rouses the mind, or its property, perception, and sensation is the resulting effect (§ 175, *c*).

501, *a*. Sympathy is *active* when it produces sensible effects. It is *passive* when its effects are insensible, as in the natural rhythm of the organic system.

501, *b*. In the perfectly natural condition of sympathy in organic life, the nervous influence is a mere regulator of the organic properties. Its natural operation is disturbed by morbific and remedial agents, and by mental emotions.

501, *c*. It is mostly in conditions of disease that we notice the results of sympathy. In health we see only the universal harmony; unless disturbed by a blush, or by the abundance of urine when cold chills the surface, or fear exerts its more mysterious sway. Disease affords the striking examples of display in the nervous power, and these examples are what most engage the attention of the physician. To trace out their complexity, as one part after another gives rise to disease consecutively in each, and as each may exasperate the morbid states of the whole, or as remedial agents may institute corresponding circles of sympathy, are the most important and difficult objects of medicine.

502, *a*. Diseases generally begin without the agency of the nerves. Morbific causes make their impression upon the organic properties of some particular part, when it commonly happens, sooner or later, that the altered state of the part is felt by the nervous centres, from whence a disturbing nervous influence is transmitted to other parts (§ 133–154, 188–193, 516, no. 7, 657, 666).

502, *b*. It is not improbable, however, that where disease invades the system extensively from its first explosion, as in idiopathic fever,

sympathetic sensibility is affected by the primary morbific cause as an important element in establishing the general predisposition (§ 149, 201, 451 *b*, 559, 660, 666).

502, *c*. Remedial agents may operate directly upon a part, and restore its morbid properties and functions without any agency of the nerves. This is generally true where the remedy is applied directly to the tissue affected; but, in all other cases, the nervous power is the medium of transmission. Upon these fundamental principles, the main art of therapeutics is or should be founded.

503. When disease, or morbific, or remedial agents transmit their influence from any part to the brain and spinal cord, and there develop and modify the nervous power, the modification corresponds with the nature of the impression which is transmitted to the nervous centres. These transient modifications of the nervous power are similar, in principle, to the changes which occur in the organic properties, and which essentially constitute the disease. The passions also modify the nervous power in ways peculiar to each; and, in all the cases, corresponding effects are produced upon the condition of diseased parts upon which the nervous power thus modified may be reflected. That is to say, the nature of the nervous power is variously modified in all the cases; and, therefore, like external morbific or remedial agents of different virtues, modifies the vital states according to its own acquired modifications. The nervous power, therefore, thus acquires, more or less, the virtues of the exciting causes, and becomes, more or less, a substitute for them (§ 226).

504. Various circles of sympathy are generated by the action of remedial agents upon the stomach, intestines, &c. The first impression of the agent may set in motion a great range of sympathetic processes; as the operation of emetics (§ 500, *g*); and, as new impressions are sympathetically instituted, they become the points of departure for other circles of sympathy, and react upon and increase those in which they originate.

505. When the nervous power is excited by remedial agents of positive virtues, it is essentially morbific, like the remedial agents themselves. Each is, therefore, only curative by inducing new morbid conditions by which the natural recuperative tendency of the vital properties is brought into operation. The great difference is, that morbific agents alter the vital conditions more profoundly and more permanently than the remedial.

506. Impressions once made upon any part may continue for an indefinite time after the cause is withdrawn, and may continue to develop and modify the nervous influence, and direct its operation upon other parts, as when the agent was in operation (§ 487, *c*). Thus, the operation of many active remedial or morbific agents will continue to be exerted upon the system at large, for a longer or shorter time, after they shall have been thoroughly removed from the stomach, &c. Inflammations excited by cantharides, issues, wounds, &c., hold an unceasing operation, curative or morbific, upon remote parts. The specific impression made by the virus of the mad dog becomes established in the bitten part, and continues to be propagated over the system till, through the law of cumulation, an explosion of disease ultimately follows (§ 558, *a*). The same principle, exactly, is applicable to mercury, when a small dose, or its external application, produces saliva-

tion, or when miasmata give rise to fevers in a month, or six months, after their direct operation has been withdrawn. The principle is constantly illustrated in natural states of the body; as where the sphincters remain permanently contracted after the expulsion of the urine or of fecal matter (§ 514 *g*, 516, no. 6).

Here, then, we have another important law to interpret the true modus operandi of remedial and morbific agents (§ 503).

507. The nervous power pervades the whole system of motor nerves; and, although its active operation in the ordinary function of sympathy be developed mainly, if not altogether, in the central parts, it may be brought into operation by irritating any of the motor nerves (§ 474 *b*, 499). A division, or other injury of nerves going to the organic viscera, as the par vagum, may destroy their functions, or otherwise affect the vital constitution and products of the part, or induce inflammation, by the shock of nervous power thus inflicted on the organic properties of the part (§ 485).

508. The nervous systems are as liable as other parts to be affected in their organic condition by the nervous power, which, in the same way, may be actively determined upon them. But, there is this difference. When any part of the nervous system is the seat of disease, it is liable to produce greater disturbances in remote parts, than other organs when diseased. These disturbances are occasioned by the direct propagation of the nervous power, but they are apt to be less of a morbid nature than when produced by the more complex process of remote sympathy (§ 500, *a–c*).

509. The nervous power may extinguish life with great instantaneousness. When rapidly fatal, the causes by which it is brought into operation must be violent and sudden in their action (§ 455, *d*). Examples occur in the fatal effects of joy, anger, blows on the epigastric region, drinking cold water, prussic acid, sudden death from small losses of blood, apoplexy, &c. (§ 479).

In the case of joy, anger, and apoplexy, the nervous power is developed in a direct manner (§ 500, *c*), and destroys mainly by its sudden determination upon the organic properties of the brain and heart. Blows on the stomach give the same determination through remote sympathy, as do also cold water and prussic acid (§ 476½, *h*). The mode of death from small losses of blood will be explained under the philosophy of the operation of its loss (§ 943, 946, &c.).

In the foregoing cases, the nervous power is also determined with violence upon the stomach and intestines, and upon the whole capillary system of blood-vessels (§ 481, &c., 490). The general effect is also increased by the injury sustained by the brain itself.

510. The foregoing modus operandi of the several agents is similar to the causation of sudden death from injuries of the brain or spinal cord. Thus:

If the spinal marrow be suddenly destroyed, or only one half of it, by a large stilette, life is immediately extinguished. The modus operandi appears to be the following:—1st. An injury of the vital properties of all the organic viscera. 2d. A violent interruption of the concert of organic actions. 3d. An interruption of respiratory movements. 4th. A pernicious nervous power is propagated from the cord to the organic powers of the brain. 5th. Pernicious influences are propagated by the organic viscera to the cerebral and ganglionic sys

tems,—thus greatly increasing the destructive nervous influence upon themselves (§ 455, *c*). They are complex circles of nervous influence, but are determined by exact laws, and each circle has its distinct individuality, although involved in each other.

A like explanation is also applicable when a sudden destruction of life is effected by crushing the brain.

511. It is upon the principle that the effects of the nervous influence depend upon the exact nature of the impressions made upon the nervous centres, whether direct or indirect (§ 426, 500), that we must explain the differences in the results of slightly-varied experiments relative to these parts; those, for instance, by which the brain or spinal cord is slowly destroyed interrupting the harmony of actions and the organic functions more gradually, and therefore less fatally, than such as produce their destructive effects with greater rapidity.

V. THE LAWS OF SYMPATHY, AND THEIR APPLICATION TO PATHOLOGY AND THERAPEUTICS.

General Facts and Laws relative to the Cerebro-spinal and Ganglionic Systems.

512, *a*. The various nervous communications of the intestinal canal with the brain and all other organs are demonstrative of the ascendant influence which the stomach, particularly, possesses when acted upon by remedial agents. We see all this exemplified, analogically at least, in the endless remote derangements which follow the common irritations and morbid states of the organ, as, also, of the intestines. We see, indeed, the whole in natural progress. When, for example, hunger operates, an actual sensation is then felt by the brain, and the mind, of course, participates (§ 323). Numerous and complex influences may be thus brought into operation, of which the stomach is the primary source. The will, being excited, brings into action all those muscles which are necessary to obtain a supply of food, and other muscles to effect its mastication, and convey it to the stomach. Various sympathetic organic influences are, in the mean time, taking place, which it is unnecessary, as it might be difficult, to explain. Many of these organic influences spring from the mind itself. Thus, the brain feeling the sensation of hunger, the salivary glands begin to pour out their fluid at the sight or smell of food, or even at its expectation. The food establishes an influence upon the nervous centres, by which an exciting nervous power is constantly propagated to other parts. The bile, saliva, &c., are thus increased, though other more direct sympathetic influences contribute to these results. The stomach being supplied with its wants, all these influences cease, and a new order arises. Cut off the par vagum and none of them will obtain, unless feebly through the ganglionic and spinal nerves. When the food has undergone digestion, and all exciting impression is removed from the stomach, all the reflected influences of the brain and spinal cord cease in consequence.

512, *b*. The vascular action and the glow of warmth, which are lighted up in the skin of the fasting, half-frozen traveler, and his invigorated strength before digestion has made any advances, and the flow of bile which is determined by the action of food on the stomach, especially where the food is of an animal nature, and therefore,

likewise, operative in part through its stimulant virtue; or, again, the copious perspiration, and other results, which often follow immediately a draught of hot water, illustrate the whole philosophy of this apparently entangled subject of sympathy, whether in relation to natural, morbific, or remedial agents; and we learn from these obvious examples that the essential principle is simple, and readily explains all the diversified phenomena, which are purely effects of a complex play of sympathies, whose original starting point is the gastro-intestinal mucous membrane. But when, in the case of the food, it shall have been digested, and have entered the circulation, some of its earliest and strongest demonstrations may have disappeared. It is worthy of remark, too, that such is often the immediate effect of food upon the great nervous centre, that sleep is almost irresistible, or apoplexy follows, "paulo post prandium," as no unusual result; the nervous power being determined, in the former case, upon the organic properties mildly and agreeably, in the latter with sudden and destructive violence (§ 226–233, 480, 500, 508–511).

513. Physiological conditions, like the foregoing, are so intelligible as to be peculiarly important in illustrating coincident problems in pathology and therapeutics. Whenever well-pronounced sympathetic influences are propagated from one organ to others through the medium of the cerebro-spinal system, in their natural states, and by natural stimuli, as by food, these influences are generally greatly increased, as well as modified in kind, by morbific and by remedial agents (§ 524, no. 1).

514, *a*. The foregoing considerations lead me to the statement of one of the most important laws in physiology, which is alike applicable to the cerebro-spinal and ganglionic systems, namely:

"When impressions, made by the action of external stimuli on sensitive nerves, give rise to motions in other parts, these are never the result of the direct reaction of the sensitive and motor fibres of the nerves on each other. The irritation is conveyed by the sensitive fibres to the brain and spinal cord, and is by those communicated to the motor fibres."—Müller (§ 445, 462–472).

The foregoing law is in operation in all cases of remote sympathy, whether of a physiological, pathological, or therapeutical nature (§ 455, *c–h*). It is clearly exemplified in the natural process of respiration, by the analogous results of emetics, &c. In respiration, the want of air is felt through the medium of the sensitive fibres of the pneumogastric and sympathetic nerves, and appears to be concentrated about the medulla oblongata. The nervous power is thus developed, and is then reflected upon the various motor nerves which supply the muscles of respiration; when the action of these muscles follows as a consequence (§ 233, 462–472, 500).

514, *b*. The only remarkable difference in the physiology of vomiting from that of respiration consists in the primary impression being made upon the same nerves in the mucous tissue of the stomach, and the convulsive movement of the respiratory muscles. A radical difference, however, obtains in the influences which may be exerted by an emetic upon the organic states; especially in their diseased conditions. This, too, will depend greatly upon the cause of vomiting; and so of every other agent, according as it may be natural, morbific, or remedial. When the effects depend upon sympathetic influences,

the morbific and remedial agents so modify the nervous power that it alters the existing condition of the organic properties and functions of all parts upon which its positive action may fall (§ 129, 226, 227).

If the stomach itself be the seat of disease, even its mucous tissue, the remedial effect of any agent may not be wholly, or principally, due to its direct action upon the organ, but may be also exerted through a chain of causation exactly similar to that by which the respiratory muscles are thrown into action in respiration or vomiting. This must be obvious enough in the case of peritoneal disease of the stomach; and it is equally true of diseases of its mucous coat, that the impression of the remedy is transmitted, more or less, through the sensitive fibres of the pneumogastric and ganglionic nerves to the brain and spinal cord, when the nervous power is reflected, with an alterative effect, through the motor fibres of the same nerves upon the mucous, as upon the serous, tissue of the stomach. The same philosophy applies to the muscular coat of the stomach in the action of an emetic, and to the same tissue of the intestines when peristaltic movements are excited by cathartics (§ 657 *a*, 658).

In the case of vomiting, the impression upon the stomach may be direct or indirect; and the various mental as well as physical modes by which it may be produced, unfold an extensive range of sympathies, open a wide door to a knowledge of the modus operandi of morbific and remedial agents, and confute the physical and chemical doctrines of life and disease. But this is only at the threshold of an endless number of *analogous* examples supplied by the mucous tissue alone; since "the whole system of *respiratory* nerves can be excited to action by the irritation of *any part* of the mucous membranes from the mouth to the anus, or from the nostrils to the lungs, or of the urinary organs."

514, *c*. We thus comprehend how an emetic of the most simple nature may suddenly arrest a paroxysm of hooping-cough, or of spasmodic asthma, or of hysteria. The emetic, through the foregoing process, induces new movements in the affected muscles, and thus ends the paroxysm. Dr. Greenhow, for example, has lately related, in the London Medical Gazette, the case of a man, who was affected with a choking, as if a ball was rising in his throat, and shortly after a violent hiccough began, which continued for several days. About the eighth day, his wife, sister, and maid-servant, "got into the same state;" the affection being sympathetic in the last three cases, and induced by the operation of the mind (§ 227, no. 1, 230). "It was a painful spectacle, though a somewhat ludicrous one, to see four individuals all hiccoughing at the same time." Opium, valerian, asafœtida, camphor, magnesia, &c., failed entirely of affording relief. "However, something taken by the maid-servant made her vomit, and from that moment the complaint ceased. A mustard emetic was immediately ordered for the others, when the sister and wife were also relieved; but not so the husband, whose attack, however, was always suspended by vomiting, but soon returned." In the case of the husband, there was present a state of disease, which continued to reproduce the paroxysms; but in the other three there was little else than the spasmodic action of the muscles. Dr. G. says he "always afterward found that vomiting put an end to attacks of hysteria, and believes that the *dread* of an emetic has often had the effect of checking

an hysterical attack;" in which case the mind develops a controlling nervous influence.

514, *d*. Consider, next, an example of the manifestation of sympathy between the skin and other parts, as indicative of the modus operandi of remedial and morbific agents when they establish their influences upon distant parts through the medium of the skin.

Volkmann, in pointing out the great difference between the trunks and the minute terminations of the nerves in the power of exciting reflex motions, prefers the skin for illustration; which, he says, surpasses all other organs in the property of exciting these motions. When an animal, for example, is under the influence of opium, the slightest touch of the skin is frequently sufficient to give rise to strong spasms, while reflex actions excited by irritating the distinct nerves of the skin are generally less. The philosophy is the same when cold air, or cold water, restores a patient from a state of syncope. A drop of cold water, when snapped upon the face, rouses the subject by transmitting an impression through the cutaneous nerves to the nervous centres, which instantly develops an exciting nervous influence that is then reflected upon the muscles of respiration, and upon the heart and extreme blood-vessels. The same law governs, also, the constant mutual interchange of action between the skin and alimentary canal, the skin and kidneys, &c., whether in health or disease. From these examples of a great fundamental law, we readily obtain the modus operandi of mercury, iodine, blisters, issues, &c., when applied to the skin (§ 226, 232, 527 *b*, 559, 666).

514, *e*. With the qualifications stated in sections 458, 459, it is "a general law, that, whenever general spasms are excited by local impressions, the phenomenon depends on no other communication between the sensitive and motor fibres than exists in the spinal cord. In many cases, however, local irritation of the nerves gives rise, not to general, but to local muscular spasms." "In the contraction of all the perineal muscles in expelling the semen, which are exerted by irritation of the sensitive fibres of the penis, the spinal cord is the medium of communication between the sensorial impressions and the movements."—MÜLLER.

514, *f*. Many "muscles invested by sensitive membranes, and are not themselves exposed to the direct stimulus, can only be excited to action by irritation of the sensitive property of their investing membrane, the transmission of this irritation to the nervous centres, and the propagation of the motor influence from the nervous centres to themselves. Thus, the contractions of the glottis and air-passages, excited by the contact of irritating gases, are not the immediate result of the irritation of the parts themselves, but of the excitement of the sensitive fibres distributed to the mucous membrane and the reflected influence of the brain and spinal cord upon the motor nerves of the muscles. The movements of deglutition belong to this class. The stimulus of the morsel in the fauces excites the act of deglutition. In this case, the sensitive nerves which transmit the impression to the nervous centres are, according to Dr. Reid, the glosso-pharyngeal, the superior laryngeal, and the branches of the fifth, sent to the soft palate and isthmus of the fauces. The motor nerves for the movements of deglutition are the pharyngeal branches of the par vagum. A like explanation applies, also, to the irritations of the sphincter ani and the

sphincters of the bladder. The muscles cannot be themselves stimulated by the excrement and the urine; but these matters act upon the sensitive nerves of the mucous membrane and excite the spinal cord, which, as if *constantly charged with motor influence, reacts upon the muscles.* In this case the phenomenon appears to depend on no other communication between the sensitive and motor fibres than exists in the spinal cord. Hence, after injury of the spinal marrow, these sphincters become relaxed."—MÜLLER.

The operation of cathartics involves more complex laws. These are agents of specific virtues, and are capable of modifying the vital states of the intestinal canal and of parts remotely situated. Their direct impression is exerted upon the intestinal mucous tissue; but the *muscular* is brought into increased action both by contiguous and remote sympathy (§ 497). It is not improbable, indeed, that remote sympathy is concerned in the ordinary peristaltic movements that are induced by the natural contents of the alimentary canal (§ 475, 490); though observation assures us that, as in the case of the heart, the natural stimuli maintain the movements without any well-pronounced reflection of the nervous power upon the muscular coat (§ 475, 490). But in the case of cathartics, something more happens. The influence being extended to the nervous centres, the nervous power is propagated through motor fibres of the pneumogastric and sympathetic nerves upon the intestinal mucous tissue, by which the various influences of these agents are increased, as in the experiments by Wilson Philip (§ 491).

514, *g*. The sphincters remain contracted after the expulsion of the fæces and urine. This is owing to the permanence of the impression upon the mucous tissue, which maintains an excitement of the nervous influence till the excretions are again deposited. And so of the continued influences of remedial and morbific agents long after the agents themselves have ceased to operate; the impressions remaining upon the parts where their direct action had been exerted. In this way miasmata, the virus of the mad dog, mercurial and other remedies which may be slow in the full development of their effects, establish their influences where their direct action may fall, and these are subsequently and slowly propagated to other parts (§ 516, nos. 2 and 6, 518 *b*, 666).

514, *h*. More complex examples of the law with which this section was begun will be presented hereafter. Such as have been stated are intended as introductory to the series of laws which are soon to follow. But we see from examples already produced, that when sympathies are set up in one part they may become the cause of sympathies in other parts, and that in this manner remedial and morbific agents, which begin their action on some given part, may establish very complex circles of sympathy, each modifying the others through new influences upon the nervous power (§ 228). When the food, for instance, as in § 512, induces vascular action and warmth in the skin before digestion commences, that organ, in consequence, reflects salutary influences on the digestive organs, and thus promotes digestion. When tartarized antimony, in small doses, establishes its sudorific impression, the skin becomes the source of many sympathetic influences upon other organs; thus showing, also, that it is not the perspiration, but the vital change in the organ itself which leads to results that can-

not be imitated by any other mode of exciting this excretory function. And so, more or less, of other parts upon which the antimony may exert its primary sympathetic effect (§ 863, *e*).

Thus it happens, that whether certain remedial agents are applied to the stomach or skin, sympathetic influences are propagated to each, as well as from each to other organs, while each, in its turn, reflects the impressions back to the brain and spinal cord, from whence they are again returned with increased intensity; or organs not before involved are ultimately brought under their influence (§ 129 *h*, 674 *d*). And so of disease of any given organ; which is only equivalent to the influences of morbific causes (§ 647, 660).

If two or more remedial agents be united, it is readily seen that their combined effect may be extended from the stomach to various parts of the body, and from thence sympathetic influences propagated among themselves, and variously determined upon other parts.

514, *i.* We may now regard an example which presents a union of the physiological, pathological, and therapeutical principles, as set forth by myself, in their relation to the nervous influence; all referable to one common law in its connection with modifications of the nervous power (§ 226). Thus: "Certain cases," according to Marshall Hall, "as hydrophobia, epilepsy, hysteria, and certain remedies, as strychnia, cantharides, &c., not only induce augmented excitability, but manifest their effects upon the organs which are physiologically under the dominion of the excito-motory power."

514, *k.* Finally, a glance at the physiology of the contraction of the iris may aid our understanding of the complex sympathetic influences of morbific and remedial agents, and of the applicability of the following physiological laws to the modus operandi of such agents.

It is first worthy of observation, that the iris may be pricked with a knife without exciting contraction, while it is exquisitely sensitive to the action of light (§ 74 *a*, 188½ *d*, 136, 137). The co-operation of a sensitive and motor nerve, through the medium of the brain, is necessary to this phenomenon. The impression upon the retina being transmitted to the brain through the optic nerve, is reflected upon the iris through the motor ciliary nerve. This may, perhaps, open the eyes of the chemist as to the true doctrine of vision (§ 188½ *d*, 500 *n*). But it is a more interesting fact, that when one eye is closed, and the other open, the pupil of the closed eye will follow, in a measure, the movements of the open eye; and this will happen to an amaurotic eye when the sound one is exposed to the stimulus of light. This sympathy between the two eyes, as well as in other respects, and the harmony between the two ears, involve very delicate considerations as to the influences of the nervous centres, and may be employed in tracing out the philosophy of many obscure interchanges of action among different organs, either in their natural states, or when they are disturbed by morbific or remedial agents.

514, *l.* A multitude of illustrations may be brought to the same purpose, which show us, also, how complex may be the influences of morbific and remedial agents, and how the mind may participate, when these agents operate upon the organic properties which conduct the insensible movements. Thus, sneezing is commonly produced by the action of stimuli upon a nerve of common sensibility distributed from the fifth pair to the mucous tissue of the nose, and the

reflection of this irritation upon the respiratory nerves. But the stimulus of the sun's light may produce sneezing by acting first upon the optic nerve, and through that medium upon the nervous centres. The nervous power thus developed is reflected upon the Schneiderian membrane through the branches of the fifth pair which impart common sensibility to the nose (§ 198). Here a new sensation arises, which is sent back to the brain and spinal cord, the nervous power again developed, and, according to relations between that membrane and the respiratory organs, and the nature of the remote cause, the nervous power is now reflected upon the respiratory muscles, when sneezing follows as the result of the convulsive movement. (See, in connection, § 188½ *d*, 500 *n*.)

The mind itself will do the same thing by dwelling intensely on a former paroxysm of sneezing. Here the nervous power is excited in a direct manner by the mind, and is then, as in the foregoing case, directed upon the nasal branch of the fifth pair. And so of sympathetic yawning, sympathetic micturition, &c.

514, *m*. The olfactory nerve is mostly endowed with specific sensibility, and is only excited by odors, while they have no such effect upon the nasal branches of the fifth pair, unless the odors be at the same time of a pungent nature; and then it is the *pungency*, not the *odor*, that operates. Odors affect the mind agreeably or disagreeably. The smell of a rose may have no other effect than that of so impressing the brain as to give rise to a pleasurable sensation. But, in some constitutions, its impression will excite a very complex train of sympathies. Its effect may be at first pleasurable, but followed immediately by the transmission of a disturbing influence to the heart, or stomach, or even to the intestines. The heart may be thus depressed in its action, the stomach nauseated, and the bowels have been purged by the same cause. Hence the poet's expression, to "die of a rose in aromatic pain." Even the recollection of disagreeable results from offensive odors brings on nausea and vomiting (§ 500, *i*. See, in connection, § 188½, *d*).

Laws of Action of the Sympathetic Nerve, and the Propagation of Impressions in it.

514½, *a*. Having now, and in former sections (§ 471–475, 477–496, 500), stated the most important facts and laws which relate to the cerebro-spinal system, whether acting independently, or in connection with the sympathetic nerve, I shall proceed to speak of those which concern especially the latter system. But the cerebro-spinal is so interwoven with the sympathetic nerve, it is obvious that the influences which appertain to the brain and spinal cord must be more or less common to the ganglionic nerve (§ 115).

514½, *b*. The following laws are generally inferable from what has been already said of the nervous power, and of sympathy. But, I have deemed it most useful to the young student of medicine, and possibly to the more advanced, to present them in a brief and systematic form, with comments of a practical nature. The quotations are from Müller, unless otherwise stated. In this branch of physiology, Müller is eminently philosophical; and in thus adhering to the path of nature, he is arrayed in opposition to those chemical and physical views with which he has thought proper to oblige the mate-

rialists of the age, and which prevail in other parts of his work on Physiology. After variously expounding the laws of the vital principle, and reasoning as a philosopher upon the abstract subject of reflex nervous influence, like Marshall Hall, and others, he cuts loose from all analogies, and from the whole philosophy of the vital properties. As in the equally remarkable case of Wilson Philip, he ascribes all the organic functions and products to physical and chemical agencies,—maintaining that,

"The formation of any one of the peculiar secretions, the essential proximate constituents of which do not exist in the blood, presupposes *the operation of a special chemical apparatus, whether this be a membrane or a gland.*" Of all morbid states, he affirms, that "*All these phenomena are owing to a noxious matter absorbed into the blood, or generated in it.*"

The same humoral interpretation is applied to the modus operandi of remedies, which, like morbific agents, are supposed to be taken into the circulation by endosmosis or by capillary attraction, and it is quite "*uncertain*," he says, "*whether the matters are first received into the blood-vessels or lymphatics.*"—MÜLLER'S *Elements of Physiology.* Also, *Medical and Physiological Commentaries*, vol. i., p. 37, *note*, 56, *note*, 565, 570, 684, 685; *and this work*, § 494, *dd.*

I have thus adverted again to the discrepances in the views of this philosopher, that the reader may appreciate the value of his luminous exposition of the laws of sympathy, since they contemplated no theoretical conclusions in pathology or therapeutics.

515. It is still a controverted question how far the sympathetic nerve is independent of the brain and spinal cord, though in their natural state the intimate physiological relations of the latter to the former admit of no doubt (§ 459). Microscopical investigations have been carried on extensively with reference to this inquiry by Valentin, Volkmann, Bidder, Müller, Remack, Henlè, Purkinje, Rosensthat, Pappenheim, and some others less known in the walks of physiology. As may be readily supposed from the nature of the investigation, and the means relied upon, there has been great discrepancy, and even entire opposition, in the principal statements and conclusions; all tending to strengthen my objections to the use of the microscope in anatomical and physiological inquiries (§ 131. Also, *Med. and Phys. Comm.*, vol. i., p. 699–712; and *Examination of Reviews*, in vol. iii., p. 6, 89).

We know enough, however, of the relations of the sympathetic nerve and cerebro-spinal systems, and of their connections with other parts, and enough of the phenomena which grow out of those relations, to lay down the important laws of sympathy; and these are what we require for practical purposes.

Of the Actions of the Sympathetic Nerve in Involuntary Motions.

516, *a.* 1. "All the parts subject to the influence of the sympathetic nerve are incapable of voluntary motion."

2. "The parts which are supplied with motor power by the sympathetic nerve still continue to move, though more feebly than before, when they are separated from their natural connections with the rest of the sympathetic system, *and wholly removed from the body.*"

This is an important fact, as contributing to prove that the viscera of organic life are not dependent on the nervous power for the ac-

tions, but that all the essential processes are carried on by properties peculiar to themselves (§ 184, 188, 205–216, 222–232, 475, 476–492, 494, 500).

516, *b*. Clear demonstrations of the foregoing law abound in the history of organic life. That in relation to the extirpated heart, which has been stated in a former section, is alone abundantly conclusive (§ 498, *e*).

516, *c*. Again, if the intestines be removed from the body, and some part of them irritated, their motion is increased, "and this effect continues long after the stimulus is withdrawn, and does not *immediately* attain its greatest degree." And so with the heart (§ 516, *b*). Its contractions may not begin till some seconds after it is irritated, and they may then be long continued (§ 516, nos. 6 and 7). The phenomenon, and its causes, are the same as when the leaflets of the mimosa sensitiva contract when irritated by a pin.

516, *d*. We have, therefore, in these examples, a type of all the movements which arise from continuous sympathy (§ 498, 524, no. 2), and a proof of the existence of the organic properties, of their independence of the nervous system, and of the active, vital nature of the dilatation of the heart (§ 498, *e*). The principle is of great moment in a pathological and therapeutical aspect. We see, for example, that the direct facts, and the analogy supplied by the active dilatation and contraction of the heart, substantiate a rhythmic, consentaneous movement of the arteries (§ 384). We carry this with the other facts to pathological conditions. Thus, when the extreme capillaries of the skin, as of the finger, for instance, or any other part, are irritated mechanically, or by any chemical or other agent, an inflammation may be excited at the point irritated; just as the heart, or intestine, is roused into action by the prick of a pin. The inflammation then extends, progressively, from the point irritated, the finger throbs, its principal artery begins to pulsate, and finally the radial. And so of the irritation of the ducts of glands, by which the glandular secretion is increased. At other times, remote sympathy, or the operation of the nervous power, is simultaneously brought into action (§ 498, *f*, *g*).

3. "Hence, all the parts endowed with motion and supplied with nerves from the sympathetic, are, in a certain degree, independent of the brain and spinal cord," as well as of the sympathetic nerve.

The same affirmation is true of the muscles of animal life (§ 487, 494 *d*).

4. "The central organs of the nervous system can, however, exert an active influence on the sympathetic nerves and their motor power" (§ 222–232, 475).

This is a very important physiological fact to the physician, and is fully established by the experiments of Philip, Valentin, Müller, and others, and is conspicuously shown by the effects of the passions.

It is through the liability of the whole body to be influenced by the nervous power of the brain and spinal cord, through the sympathetic nerve, as well as through their own nervous contributions, that I interpret the whole philosophy of sympathetic diseases, and the operation of all morbific and remedial agents when they affect parts that are distant from the direct seat of the action (§ 495–507).

5. "The experiments of Dr. Philip tend to show, that distinct parts of the sympathetic, and the movements dependent upon them,

as of the heart, for example, do not derive their nervous influence from distinct regions of the brain and spinal cord; but, on the contrary, that the whole brain and spinal cord, or every part of them, can exert an influence on the motions of the heart," of the capillary blood-vessels, of the intestinal canal, &c. (§ 476–492, 494 *d*).

6. Next follows a most important physiological law, when applied pathologically and therapeutically, and by which I explain the continued operation of morbific and remedial agents long after the cessation of their direct action.

"The movements excited in organs which are under the influence of the sympathetic nerve, by irritation applied to them or to their nerves, are not transitory and momentary contractions. They are either *enduring contractions*, or they consist of a *long-continued modification* of the ordinary rhythmic action of the organ. Hence, in these organs, the reaction consequent on the irritation *is entirely of longer duration than the action of the stimulus*" (§ 514 *g*, 516, no. 2, *c*, 487 *e*).

Now, what is true of the nervous influence as it respects its effect on the great organs is, according to the experiments of Dr. Philip, and others, equally so of the small blood-vessels, and the vessels of secretion.

The foregoing law is founded upon experiments in which the irritation produced by agents is not directly morbific, such as galvanism and mechanical irritants. If such causes, therefore, will continue to derange the actions of the organic viscera after the operation of the causes is withdrawn, those which are truly morbific will continue in action longer, and establish disease more permanently through the same channel. And so of remedial agents. The law is shown, naturally, by the unabated contraction of the sphincter muscles after the evacuation of urine and of fecal matter.

This physiological law, therefore, is of vast moment in interpreting the effects of remedial agents, corresponds with that natural condition which is set forth in § 514, *g*, shows us how the influence of an emetic or cathartic may continue to be felt by the lungs, the brain, &c., long after their most characteristic effects are over; or how an uninterrupted and cumulative action of the foregoing nature may be maintained by small and repeated doses of mercury, antimony, &c., or by the peculiar change which leeches establish in the vessels to which they are applied, and, finally, how a morbific cause of yet other specific virtues may, by its momentary action on the mucous tissue of the stomach, or lungs, &c., be kept up in those tissues long after the remote cause is withdrawn, and progressively shed a morbific influence over all the organs of the body (§ 150, 498 *f*, 545, 549, 550, 558 *a*, 559, 666). The impression is maintained, in all the cases, upon the organic constitution of the organs immediately impressed, for an indefinite time after the agents themselves have ceased their operation. While that impression remains the influence which has been thus exerted continues to modify, more or less, the vital nature of the parts, and to be propagated with various effect upon distant organs. We have seen the simple physiological elements operating through the combined media of the cerebro-spinal and sympathetic systems, in section 514, *f*, as it respects the permanent contraction of the sphincter muscles, and in the explanation which I have given of the persistence of their contraction after the expulsion of the urine and fæces.

Now, that principle which physiologists have limited to an explanation of the natural phenomena in relation to the sphincters, is most extensively applicable in resolving the problems of disease and of remedial influences, and I shall carry it, in connection with the foregoing law, far into the labyrinth of organic life, as it may fall under the cognizance of the pathologist and therapeutist. In the aspect, alone, of its bearing upon the amount and frequency of doses, &c., in the treatment of disease, the law is of incalculable magnitude (§ 857). The same impressions which are left upon the bladder and rectum after the evacuation of their contents, and which continue to propagate the nervous power upon the sphincter muscles, and to maintain them in a state of contraction till the urine or the fæces again accumulate, equally appertain to morbific and remedial agents. Hence I deduce an important practical rule for the regulation of doses, the frequency of their repetition, the order of their application, &c., according to the nature of disease, the nature of the agents employed, the duration of their effect, &c.; all of which is amply sustained by the results of practice, especially those which so constantly accrue from excessive doses, and their repetition before the influences of the preceding shall have duly abated, or where other means should have been substituted. There is nothing, I say, of greater practical importance in the whole circuit of medicine than what is involved in this section, and in those which I shall have brought to its illustration. We must attend to the physiological facts. The effects of mistaken practice are entirely insufficient to enlighten the understanding. Physiology must be brought back as the basis of pathology, the groundwork of therapeutics; keeping ever before us those natural laws through which the evil and the good of practical medicine are essentially determined. However various the causes and the phenomena, a concurrence of principle and of laws obtains among the whole; which is the surest proof that the doctrines here taught have their deep foundation in nature (§ 237). There is nothing that can assure us more emphatically of the importance of sweeping away the chemical and physical doctrines of life, of disease, of therapeutics, than the facts about which I am now interested, and the mischief which has arisen either from removing pathology and therapeutics from their proper foundation, or in deriving their foundation from the laboratory of the chemist (§ $5\frac{1}{2}$ *a*, $350\frac{1}{2}$, $350\frac{3}{4}$, 819, &c.).

7. The next following law shows that the organs of organic life are essentially a system by themselves, that their actions are carried on by their own inherent powers, and are essentially independent of the nerves, and that the great office of the sympathetic nerve is to maintain a harmony or concert of action among them. It will be seen, however, that the capital error occurs, that "*the immediate cause of the involuntary motions lies in the sympathetic nerve*" (§ 516, no. 2).

"The immediate cause of the involuntary motions, and the cause of their type, lies neither in the brain nor in the spinal cord, but in the sympathetic nerve itself. Even the influence of the ganglia is not necessary. The branches of the sympathetic going to an organ may be entirely removed, the twigs distributed to the substance of the organ only being left, and the motions will be maintained as before, the reciprocal action between the muscular fibres and these ultimate nervous twigs being apparently adequate to their production."

The phenomena are the same in plants. They depend, not on the nervous power, but on the organic properties of every part. This appears from Müller himself, who says that, "to excite the motion of the leaflets and petioles of the mimosa, it is not necessary that either the intumescence, or even the leaves, should be touched. The *stimulus* may be applied to a more or less distant part (§ 184, 207, 208, 233, 257, 490, 502, 524, no. 2. Also, *Med. and Phys. Comm.*, vol. i., p. 17, 474–480, 572; and *Essays on the Philosophy of Vitality and of the Modus Operandi of Remedial Agents*, p. 42, 43, *note*).

8. Now follows the great law, that, notwithstanding the foregoing separate nature of the organic properties and their essential independence of the nervous power, the organic properties may be greatly *influenced* through the cerebro-spinal and sympathetic systems. What is said, however, of the "extreme branches of the sympathetic" must be regarded as erroneous (no. 7), though it be probable that influences may be determined sympathetically through the ganglia and plexuses of the sympathetic nerve (§ 459). The law is thus expressed by Müller:

"Although, from the foregoing observations (no. 7), it is certain that the extreme minute branches of the sympathetic have still the power of regulating the movements of the parts not subject to the will (when such parts are abstracted from the body), yet it is not less true that both the brain and spinal cord, and the ganglia themselves, when in a state of irritation, exert an influence on these movements as long as the contractile organs are connected with them through the medium of the nerves. The brain and spinal cord are, however, also to be regarded as the source of the power of the sympathetic itself, which would, without them, become exhausted" (§ 524, no. 6).

The last clause of the foregoing law is inapplicable to the fœtus without brain and spinal cord (§ 493, *b*). It is nevertheless true, however, in a general sense, that "the phenomena of radiation and coincidence of sensations, of the associated and reflected motions, are independent of the action of the sympathetic, and comprehend by far the greater part of the sympathetic phenomena formerly attributed to its influence."

The second clause involves all the phenomena of remote sympathy, of the operation of the passions, and of other direct cerebro-spinal influences on the organic viscera (§ 227, 230).

9. I would vary the phraseology of the following law, to render it more conformable with the facts. I do not believe that the sympathetic nerve is any longer charged with the influence derived from the brain and spinal cord than during its connection with those parts. So far as this nerve manifests an influence after that connection is severed, it is itself the source of that influence; and this conclusion is sustained by the fœtus without brain or spinal cord.

"It results," says Müller, "from the fact already stated (nos. 7 and 8), that the sympathetic nerve is charged, as it were, with nervous power by the brain and spinal cord, which may be regarded as the sources of nervous influence; but that, when once charged, it continues to emit this influence in the manner peculiar to itself, even when the farther supply is, for a time, diminished" (§ 516, nos. 7 and 8; § 520, 524, no. 5).

The foregoing fact clearly evinces a certain independence of the

sympathetic of the cerebro-spinal system, which becomes strongly pronounced when the latter is wanting in the fœtal state, or when destroyed by disease.

10. The next law shows that the action of agents is incomparably greater upon the minute terminations of the nerves than upon their trunks. It is equally applicable to the cerebro-spinal as to the sympathetic. Thus:

"The influence of narcotics locally applied to the sympathetic nerve, does not extend to the distant organs which the nerve supplies; but these organs may be paralyzed by the direct narcotization of the minute nervous fibrils which are distributed to them."

The principle is general, extending to all other agents, and has been misapplied by Müller, and many others, to sustain the humoral pathology (§ 826, *d. Med. and Phys. Comm.*, vol. i., p. 563, 564).

11. The next following law will be seen to be important in interpreting some of the various phenomena of sympathy, when they originate in the sympathetic nerve. Thus:

"The laws of reflection (in the cerebro-spinal system) stated in the third chapter of this section prevail, likewise, in the actions of the sympathetic nerve. Strong impressions on parts supplied by the sympathetic nerve may be propagated to the spinal cord [and brain], and give rise to motions of parts which derive their nerves from the cerebro-spinal system."

As an illustration of this law, "Volkmann has observed convulsions of the body produced by irritating the intestines of a decapitated frog."

With the head on, and in animals more susceptible than frogs, the foregoing law becomes extensively applicable to agents applied to the intestinal canal, or other viscera that are especially supplied by the sympathetic nerve. Thus, nux vomica produces spasmodic action of the voluntary muscles, while opium, &c., relieves them in the same way. Indeed, it is well ascertained that all the spasmodic movements of the voluntary and respiratory muscles that arise from affections of the abdominal organs depend upon irritations transmitted to the brain and spinal cord, and their subsequent reflection upon cerebro-spinal nerves. Hence, also, the action of the respiratory muscles in the vomiting excited by irritation of the intestines, by irritation of the kidneys, of the uterus, &c. And so of the natural movements of the respiratory muscles (§ 500).

12. "Impressions on parts of which the nerves are derived from the sympathetic are communicated to the spinal cord and brain, and excite the motor influence of the sympathetic nerve by reflection."

The foregoing law is an extension of no. 4, and is the most important of well-ascertained laws in medicine, as explaining all the sympathetic influences of disease, all the influences of remedial and morbific agents exerted upon parts distant from the seat of their direct action; except such phenomena as may also fall more or less under the laws 11 and 13, in connection with which this law should be considered.—(*Med. and Phys. Comm.*, vol. i., p. 569–572.)

13. "Reflected action of the sympathetic, from an impression communicated to the spinal cord by cerebro-spinal nerves, is a frequent occurrence."

The "frequency of the occurrence" is such, that it is through the

foregoing law, and the 12th, that remedial agents operate upon the organic system when applied to the skin, that diseases of the skin affect the abdominal viscera, that the contact of cold air suddenly increases the excretion, or the discharge, of urine, &c. The 12th law is involved, since both the cerebro-spinal and sympathetic nerves of the skin are the media of transmitted impressions. The chain of involved influences is of the highest importance, pathologically and therapeutically. As one of a thousand illustrations, if tobacco applied to the skin produce vomiting, the effect is first propagated to the nervous centres, from which it is reflected upon the stomach through the motor fibres of the par vagum and sympathetic nerve. This irritation of the stomach is equivalent to a direct impression from tobacco upon the stomach (§ 500, 503). It is then returned to the nervous centres through the sensitive fibres of the par vagum and sympathetic nerve, and reflected upon the respiratory muscles through the motor nerves of those organs.

But there are other profound influences, and other circles of sympathy simultaneously established. The organic properties of the stomach are affected, sympathetic influences are reverberated upon the skin, excited in the heart and blood-vessels, in the liver, and other important organic viscera, while these influences also mutually react upon the several organs, respectively, and involve other parts, such as the uterus, the kidneys, the bladder, the voluntary muscles, the sphincters, the senses, the mind, &c., in the deep complexity of results. And all this astonishing consecutive series of effects, moving forward under the most precise and fundamental laws of nature, and all the work of a moment, is set in motion by the simple application of a leaf of tobacco to the sole of the foot (§ 502).

517. Finally, the nervous power may be determined upon the organic properties of the brain, or of any part of the nervous system, by physical and moral causes, with much of the variety of effect which it produces on other parts (§ 230, 512).

518, *a*. "In certain organs, which are subject to the influence of the sympathetic and of the cerebro-spinal nerves at the same time, a voluntary influence seems to be exerted only after the long continuance of a centripetal or sensitive impression."

So far as this principle is operative, it goes to demonstrate the remarkable peculiarities, the versatile and complex nature, of the functions of the nervous system (§ 500, *j* and *k*). The urinary bladder, for example, which is under the influence of the will, presents the following phenomenon: "The will does not come into operation until a considerable accumulation of urine has taken place; in other words, not until the fluid has made a long-continued impression on the sensitive nerves of the bladder, and through the medium of these upon the cerebro-spinal axis" (§ 500, *e*).

518, *b*. Analogies evidently occur in the viscera over which the will has no control, while the facts are illustrated by the principle as ascertained in the foregoing manner; such, for example, as the long incubation of miasmata, of the hydrophobic virus, mercurial influences, &c., and the sudden accession of the phenomena to which they respectively give rise (§ 500 *e*, 514 *g*, 516, no. 6). In sections 500, *j* and *k*, are some remarkable facts which will deter us from rejecting difficult problems in sympathy (§ 513, no. 6, 523, nos. 6 and 7).

519. The following law is a farther exemplification of the foregoing comments (§ 518, *b*), and should be considered in connection with the 11th and 12th laws. Thus:

"Many parts which are supplied by the sympathetic nerve, and capable of involuntary motion only, become associated with the motions of parts subject to volition; a part of the voluntary motor influence being communicated involuntarily to them; just as in the associate motions of the voluntary muscles."

Of this, examples are afforded by the iris, the vesicula seminalis, and intestine (§ 500, *e*).

520. The problem is propounded by Müller, "Can reflex phenomena be produced in the sympathetic nerve through the influence of the ganglia, and independently of the brain and spinal cord?"

He is disposed to answer the question negatively, and observes that, "We are at present entirely ignorant as to whether irritations in one organ ever, through the medium of the sympathetic, give rise to sympathetic movements in another." And yet when he comes to reason from the phenomena of nature, he remarks that, "in many cases, it is probable that the reflections are produced through the medium of the sympathetic alone;" and again, that in such cases, "it is probable that the sympathetic nerve alone is engaged in the production of the phenomena." This is enforced by the considerations, that, "the peculiarity of the organic or sympathetic nerves, namely, the difficulty of distinguishing either origin or termination of them, their want of (definite) arrangement into trunks and branches, and the increase in their course which they frequently undergo, is certainly in favor of their actions being propagated in all directions *from the central points of the ganglia.*"

This was the old doctrine, and that such is the fact to a certain extent, and under certain circumstances, appears to be evinced by some of the phenomena of contiguous sympathy (§ 497), and by the fœtus without brain and spinal cord. It seems, also, to have been shown by the experiments of Henlè, Grangier, and Valentin, upon the intestines. But careful attention is necessary, in these cases, to distinguish what is due alone to the independent organic properties of any part, from that which is owing to an influence exerted upon those properties by the nervous power (§ 222, &c., 507, 516, nos. 7 and 8).

521. "It is not proved, and several facts have been observed which are opposed to the belief, that the ganglia can exert an insulating action so as to impede the transmission of motor influence from the brain and spinal cord" (§ 523, no. 4).

All the phenomena of sympathy in organic life appear to be opposed to this belief.

522. "It is not certain that the ganglia are the cause of the parts supplied by the sympathetic nerve being withdrawn from the influence of the will."

It is probable that the cause is inscrutable, since it is owing to peculiarities in the vital as well as mechanical constitution of the two systems of nerves. We see, however, that influences are as readily transmitted from the brain to the organic viscera as the will operates on the voluntary muscles; and while the passions scarcely operate in animal life, they have a powerful and rapid effect on organic.

Laws of the Sensitive Functions of the Sympathetic Nerve.

523. 1. "The sensations in parts, the nerves of which belong to the sympathetic system, are faint, indistinct, and undefined; distinct and defined sensations being excited in them only by violent causes of irritation" (§ 201, *b*).

2. "The sensitive impressions received by the sympathetic nerve, although conveyed to the cerebro-spinal axis, may not be perceived by the sensorium" (§ 199½, 451).

3. "The impressions which give rise to reflex motions, when conveyed to the spinal cord by the sympathetic nerve, are, in most instances, not productive of sensations; while those impressions which are received by cerebro-spinal nerves always give rise to sensations" (§ 199½, 451).

4. "The ganglia of the sympathetic nerve do not prevent the transmission of centripetal actions in that nerve to the spinal cord. They have not an insulating power over its centripetal currents" (§ 521).

5. "The ganglia are likewise not the cause of the impressions on the sympathetic nerve being unattended with true sensation."

6. "In many cases, irritation of a violent nature in organs supplied by the sympathetic nerve gives rise to sensations in those parts. In other cases, the irritation being less violent, the sensations in the parts affected are indistinct, while distinct sensations are present *in other parts supplied with cerebro-spinal nerves*" (§ 518, *b*).

We have examples of the first kind in inflammations of the intestines and liver; of those of the second kind, in the troublesome itching of the nose and anus in affections of the intestinal canal, and pain of the shoulder in hepatic and cardiac diseases, of itching of the glans penis in chronic affections of the bladder and kidneys.

7. "The secondary sensations in cerebro-spinal nerves, consequent on irritation of the branches of the sympathetic, occur especially at the extreme parts of the organs affected."

Morbid states of the stomach produce a sense of irritation in the throat; and nothing is more common than obstinate inflammation of the mucous tissue of the fauces from gastric derangements, which are not inflammatory. In all these cases, remote and continuous sympathy are more or less in combined operation. An ignorance of the laws which govern in such instances leads many physicians to apply their remedies to the parts where the sensation is felt, or the inflammation appears. There is also a special sympathy between the extremities of the intestinal mucous membrane. Smoking, for instance, often brings on an attack of the piles; though an intermediate chain of morbific influences is also propagated to the anus through the stomach and liver (§ 498 *f*, 514 *h*).

Laws of the Organic Functions of the Sympathetic Nerve.

524, *a*. 1. "When, in consequence of impressions on sensitive nerves, secretions take place in distant parts, the brain and spinal cord are probably the medium of communication." Thus, "impressions on internal mucous membranes, as by hot drinks, frequently give rise immediately to a general sweat."

This is precisely similar to what I have said of the effect of food in lighting up a warmth in a cold skin (§ 512).

The foregoing law is true, in a general sense (§ 455, 458, 459, 490, 493 *b*, 516, nos. 7 and 8). It lies at the foundation of the whole doctrine which I have projected as to remote sympathy, and through which I interpret all diseases that spring up as consequences of each other, and the operation of morbific and remedial agents upon parts remote from the seat of their direct influence. It is variously expressed in the preceding laws.

If hot water operate upon the stomach and transmit its influence through the cerebro-spinal and sympathetic system to the whole surface of the body, it is clearly in the same way that tartarized antimony produces a sweat over the whole cutaneous organ when it determines nausea, or the act of vomiting, and therefore, also, when it acts upon the stomach in a more insensible manner. And so of the remote influences of other remedies, or of morbific agents, or of gastric, or any other primary disease. If it be the principle as laid down physiologically, it must be equally the same for analogous effects in disease, or in its treatment.

2. "There prevails a consent of action between the different parts of a secreting membrane. Thus, the state of one spot influences the condition of the whole extent of a mucous membrane" (§ 498 *f*, 516, nos. 2, 3, and 7).

This is the *continuous* sympathy as expounded in this work. It is more or less manifested in most of the diseases of all tissues, and although not a function of the sympathetic nerve, I have retained the law under that denomination (§ 141, 498, 520).

3. "A particular state of one organ, such as inflammation, or a secreting action in it, often causes the production of a similar state in other parts."

This proposition is intended in a specific, not in the general sense in which disease of one part gives rise, sympathetically, to *diverse* affections of other parts. It refers to peculiar states of disease in which remote sympathy is often remarkably characterized. Thus, "inflammation of the testicle may be replaced by inflammation of the parotid; erysipelatous inflammation of the skin may be transferred to the membranes of the brain; suppression of the secretion of one organ may give rise to increased secretion in another." So of the extension of rheumatism and gout from one part to another of very different organization (§ 142).

524, *b*. Where sympathies of the foregoing nature arise, there is often a special relation of natural functions between the respective parts, as between the uterus and mammæ. Or such relation appears to be pronounced only by morbid states, as between the parotid and testis, and the parotid and mammæ, in the mumps (§ 142).

524, *c*. As resulting from the foregoing (no. 3), though apparently the reverse of it, we have the important effect of sympathy, that when disease springs up in distant parts as a consequence of some affection of other parts, the secondary affection often proves curative of the primary one. It is the same, in principle, as when blisters, setons, &c., relieve some internal malady. Many sympathetic diseases have, as it were, a great final cause, as a part of the natural constitution of animals. The ordinary forms of inflammation which supervene on

venous congestion often relieve a more formidable affection of the veins (§ 803, 804, 905. Also, *Med. and Phys. Comm.*, vol. ii., p. 519–524). Inflammation of the bronchial mucous membrane, or of the pleura, supervening on pneumonia, may assuage the latter affection. Phthisis, supervening on gastric disease, sometimes removes the latter condition. Eruptions of the skin relieve disease of the internal viscera. The hepatic action which leads to morbid redundances of bile overcome cerebral or other congestions and inflammations, and the effusion relieves the liver; while it is the tendency of inflammation of all parts to relieve itself by some morbid product, whether the disease be primary or secondary. Nature, in these cases, has supplied indications for the hand of art; and, instead of waiting for the indirect and spontaneous course, we should abstract blood, or hasten to establish those changes which result in increased secretions, &c. While, also, we are accomplishing these results, which, abstractedly considered, are depletive, we are acting, at the same time, upon the diseased properties, either by a direct impression upon them by the remedies, or indirectly by the nervous power (§ 503). But this is mainly true of the natural processes as it respects spontaneous hemorrhage. All the other natural effusions are greatly wanting in those direct remedial effects which are exerted by therapeutical agents that lead to similar products.

"The principle of the balance of sympathy teaches us how we must avoid aggravating the morbid condition of one organ by the means which we apply to another; but it also teaches us how we may produce a change in the state of one organ directly inaccessible to us by effecting an appropriate change in another."—MÜLLER. Here Müller is any thing but a humoralist, as, also, throughout his disquisition on the laws of sympathy; though in other places he lays down the broad doctrine that morbific and remedial agents produce their effects by absorption into the circulation (§ 494 *dd*, 514½ *a*. Also, *Med. and Phys. Comm.*, vol. i., p. 563–571).

524, *d*. It might seem, at first glance, that the fact of the vital properties and actions being liable to disease is inconsistent with the great laws of recuperation and self-preservation. But it is not so; since morbific agents being permitted, their occasional deleterious action grows out of the natural constitution of the properties of life, which is physiologically designed for the healthy processes. That these processes may be carried on, the properties of life must be susceptible of being acted upon by foreign agents, as food, &c., and universally by the blood. They must also be liable to modifications in their nature, that certain specific functions may be instituted from time to time, as the processes of gestation, lactation, &c., and the powers of all other parts must be so constituted as to adapt themselves to these transient modifications. And so of other changes, as from infancy to childhood, from childhood to puberty, &c. (§ 153–159). Now the changes which arise in disease are analogous to those of gestation, lactation, and more remotely to those which occur at puberty; and they are, therefore, necessary consequences of the natural and essential constitution of the vital properties when noxious agents act upon them. We therefore return again to our proposition that it is even a necessary consequence of the final cause of the adaptation of the properties of life to the influence of salutary agents. And hence, also, the natu-

ral law of adaptation (§ 136) extends to morbid states of the system; being, for example, the principle already adverted to, which protects the general system against those morbid changes in the blood that ensue upon local diseases, and diseased parts against the irritation of their morbid products (§ 74, 129, 137 *c*, 143 *c*, 150–152, 155, 156, 387, 524 *d*, 944 *c*, 980, 1019).

4. "The ganglia appear to be the central parts from which the vegetative influence is distributed to the different organs."

5. "This radiating influence appears to be, in a certain degree, independent of the brain and spinal cord" (§ 520, 516, no. 9).

6. "It appears, however, that the brain and spinal cord are the *main* source whence the power of the organic nerves is gradually renovated."

7. Finally, it is the great office of the sympathetic nerve, through the medium of the cerebro-spinal axis, to maintain all parts in concerted action. Every organ, through this channel, is rendered sensitive to the condition of each other, and they so interchange their influences upon each, that the whole are maintained in those relative states of action which are most conducive to the good of the whole. From the exquisite susceptibility of the nervous power, and of sympathetic sensibility, which is so conspicuous in this function, arise those disturbances that are inflicted by organs upon each other, and the sympathetic effects of remedial and morbific agents (§ 201, 227, 455, 459, 449).

OF THE SYMPATHIES OF THE INDIVIDUAL TISSUES.

Sympathies of Similar Tissues.

525, *a*. Enough, perhaps, has been said upon this subject (§ 85–98, 133–143). We have seen that tissues of a similar vital constitution have the greatest tendency to sympathize with each other; but it is not necessary that the secondary disease should be of the same nature as the primary, though such is apt to be the case (§ 140, 141, 149–152).

The most frequent instances of morbid sympathies in tissues of the same nature, but remote from each other, occur in the following order (§ 162):

1. The venous tissue, in the form of venous congestion (§ 786, &c.).
2. The fibrous tissue, as in rheumatic inflammation.
3. The serous tissue, as seen, especially, in dropsical affections.
4. The mucous tissue.
5. The cellular tissue.
6. The lymphatic tissue.
7. The nervous tissue.
8. The arterial tissue.
9. The muscular tissue.
10. The osseous and cartilaginous tissues.

525, *b*. When similar tissues sympathize with each other, the sympathetic disease and its phenomena are apt to be similar to the primary affection; while, in the case of sympathies arising among different tissues, the phenomena are different in each, even though the primary and secondary affections be of the same general nature, as,

however, they are not wont to be. When like tissues sympathize with each other, the diseases and the phenomena are most analogous, because the same tissue in different compound organs has, respectively, modifications of the organic properties that are more alike than those of different tissues. And hence, mainly, the greater difference between the primary and secondary diseases of different tissues (§ 133–140).

525, *c*. When disease springs up in tissues of the same organization, but remote from each other, as in rheumatic inflammation of the fibrous tissues, for example, the primary affection often exists in some other part or parts, as the digestive organs, and is generally of a different character from the secondary affection. In these cases, which are common, the successive secondary affections may be more owing to direct sympathy with the parts primarily diseased than to the sympathetic influence of the tissue secondarily affected upon other parts of its own denomination. This is an important practical consideration, for upon its just estimate will depend much of the treatment in any given case of disease (§ 902 *m*, 905). It is also equally true that the sympathetic affections which supervene among compound organs are apt to be more or less different from the primary affection.

526, *a*. Tissues morbidly affected sympathize, continuously, in their several parts, most readily in the following order (§ 133–136, 498):

1. The venous tissue, in congestion or sub-inflammation.
2. The lymphatic tissue.
3. The cellular tissue.
4. The mucous tissue.
5. The fibrous tissue.
6. The serous tissue.
7. The glandular tissue.
8. The dermoid tissue.
9. The nervous tissue.
10. The muscular tissue.
11. The cartilaginous and osseous tissues.
12. The arterial tissue.

Owing to the peculiar vital constitution of each tissue, disease is apt to be confined to that which it first invades, but to disturb the condition of other parts with which it may be associated (§ 133–136). There are, indeed, some striking exceptions to the general rule; as, rheumatic inflammation of the ligaments is often propagated to the heart, and sometimes to a mucous tissue. Inflammation of the pulmonary air-cells is very apt to be extended to the serous tissue of the lungs, or inflammation of the liver to its investing membrane. Indeed, the serous membranes generally participate in the morbid states of the other tissues with which they are associated; nor can much intensity of disease affect any tissue without disturbing, more or less, the condition of its associate tissues. But there is much variety in these respects, even in continuous organs, as between the stomach and the small and large intestines. If the mucous coat of the small intestine be actively inflamed, it is frequently the cause of a like condition in the peritoneal coat, when the mucous inflammation may subside as a sympathetic consequence; thus representing the double operation of the law in § 524, no. 3. But, however severe-

ly the mucous coat of the stomach may be affected with inflammation, the disease is rarely propagated to the serous tissue of the organ, but far more readily to the serous or other tissues of the lungs, &c.

In respect to the arterial tissue, when we regard the extreme and capillary series as the instruments of all diseases, and, therefore, always involved in morbid action in the diseased states of all other tissues, it must rank as the first in its liability to continuous and remote sympathetic influences.

The arterial tissue itself is but little subject to other conditions of morbid action; and when the large arteries become inflamed in any part, the disease remains very circumscribed. They have, also, no great action in their natural state; it being their office, mainly, to serve as conduits for the blood. Nevertheless, they are constantly liable to sympathetic irritations, either by continuous or remote sympathy (§ 516, no. 2, *d*). The next series, or the capillary arteries, are reservoirs of blood to the extreme vessels; and to meet the exigencies of this function, they have their vital properties and actions more strongly pronounced, and are readily and manifestly influenced by the nervous power, as abundantly shown in blushing, &c. (§ 512, *b*). Hence, from this natural, physiological constitution, this series of the arterial system is more liable than the larger to irritations and augmented actions, as manifested in most inflammations.

We come next to the extreme series, in which the capillary arteries terminate; and here we find the vital properties developed in an eminent degree. This is known from their being the essential instruments of all healthy and morbid processes; and the changes in their phenomena and products during disease evince the rapidity and great extent in which these properties and actions may be modified by the nervous power, and which are brought about in an instant of time when that power is developed by the mind (§ 227, 500, 516 *d*). Sympathy, therefore, plays an incessant and extensive round among this extreme series of vessels, both in health and disease. A breath of cold air may arrest the secretion of sweat, and simultaneously determine an increased flow of urine, or fever will as suddenly augment both excretions. Coming to disease, and the influence of remedial agents, this natural relationship of the extreme vessels, and the same physiological principle, are at the foundation of the principal philosophy. Indeed, the organic properties being now more susceptible than in health, and the nervous power more intensely developed by morbific and remedial agents, its operation must be more rapid, extensive, and profound, in the latter than the former case. Hence, in part, inflammations, &c., are liable to spring up in rapid succession in various remote organs, after their invasion of any one part.

526, *b*. Next, as to the venous tissue. Here the sympathies are great, both of the remote and continuous kind, particularly the latter (§ 498). It is especially through the natural physiological sympathies of the veins, that I have endeavored to show how they co-operate in circulating the blood, as also the error of the physical doctrine of venous congestion, which supposed that this most prevalent and fatal disease depends on obstacles to the circulation and consequent stagnation of the blood. I have, therefore, endeavored to expound the pathology of this affection upon purely vital grounds, and in conformity with physiological laws (§ 786, &c.). The main physiological prin

ciple of a sympathetic nature, however, should be stated in connection with the subject before us. The venous radicles possess a vigorous action which is constantly influenced, through continuous sympathy, by the corresponding state of the capillary arteries, and by the quantities of blood transmitted to them; and that the trunks of the veins have a most visible action is shown by their rapid contraction and dilatation when cold or heat may operate upon the skin. This action is simultaneous, or nearly so, over a large extent of the veins, and is the result of continuous sympathy with the arterial system, as well as dependent on the quantities of blood transmitted from the arteries to the veins. But, when an increased quantity is transmitted, the enlargement of the veins is in no respect mechanical, but produced, in part, by the greater impression which is thus made upon the exquisite susceptibility of the organic properties of the veins.

From these few remarks as to the vital endowments of the veins, and of the active functions they perform, it is evident that they must be quite liable to morbific influences, and that remote and continuous sympathy of a morbid nature must have a ready operation among them (§ 74, 117, 137, 155, 156, 387, 422, 514 *h*, 524 *d*).

526, *c*. In respect to the lymphatic system, the principle of continuous sympathy, as in the veins, is strongly exhibited under the influence of irritating agents. If a lymphatic become inflamed at some point in the skin, the inflammation may extend rapidly along the course of the vessel, while the glands, also, will take on the same condition. Here is the great bulwark of humoralism. Here it is, and in the lacteals, that the humoral pathologists suppose that morbific agents enter the circulation and corrupt the blood, or remedial ones step in to purify it, and transmute it from a morbid to a healthy state! But, since the needle, whose prick may propagate an extensive inflammation along the course of a lymphatic vessel, is not absorbed, nor the leeches which remove the inflammation, we may rest satisfied that the poison of the viper, of the mad dog, &c., do not produce their effects upon the principle of absorption (§ 268, &c. Also, *Med. and Phys. Comm.*, vol. i., p. 480–514).

Diseases of the lymphatic glands are especially owing to constitutional predispositions, as in scrofula. When disease is developed in any one or more of these glands, others readily take on the same state of inflammation. While, therefore, under special circumstances, remote sympathy predominates in the lymphatic glands, the continuous form is mostly witnessed in the lymphatic vessels.

In the great plan of organic Design, those inlets of the absorbent system, the lacteals, are greatly exempt from morbific influences.

526, *d*. Sympathies between the brain, spinal cord, and nerves, and between the nerves themselves, are more or less in progress, in the natural state of the body. Their phenomena, however, are not very manifest, unless the nerves of some particular part sustain an irritation (§ 501). Thus, the irritation from stone in the bladder occasions morbid sensations in the penis. Other examples occur in § 513, no. 6. When disease is produced, sympathetically, in the brain, or spinal cord, or nerves, by morbid states of other organs, it is not due, as supposed by Müller, to sympathy with the nerves of the parts so affected, but to the morbid change in the general vital constitution of such parts. In this respect, the sympathies of the nervous system with other or

gans observe the same laws as apply to other sympathizing parts (§ 230).

It is difficult to analyze the sympathies which occur, specifically, in the nervous tissue, since it is the medium through which remote sympathies take place. Continuous sympathy we know to be of very limited extent, and have every reason to believe that the great final cause of the nervous system is protected by an unusual exemption of this system, especially such parts as supply the organic viscera, from severe morbid conditions, which never fail to inflict great injuries upon other parts. It is also true that diseased conditions of the nervous tissue are not easily reached by remedial agents; and the injury they inflict on other parts constantly reacts in maintaining morbid states of the nervous tissue.

The sympathies of which I am speaking refer to the changes which may be produced in the organic state of the nervous system, not to the transmission of impressions, nor to the development and influences of the nervous power, excepting so far as this power may be productive of direct changes in the organic properties and actions of the nervous tissue (§ 230). The general convulsions that arise from irritation of the nervous expanse in the intestinal canal, or from teething, &c., imply no absolute disease of any part of the nervous system; but only a strong development of the nervous power, and its forcible determination upon the muscles that may be spasmodically affected (§ 223–226, 233, 500).

I therefore think that authors, as Marshall Hall, for example, in his work on the Nervous System, are wrong in considering "all convulsive affections to be *diseases* of the true spinal or excito-motory system." On the contrary, I apprehend that in most of these cases there is no actual disease of any part of the nervous system; and it is of no little practical importance that this question should be rightly settled. The "principal causes," says Dr. Hall, "are dental irritation acting through the fifth nerve; gastric irritation acting through the pneumogastric; and intestinal irritation acting through the spinal nerves."

Now, we have variously seen how the nervous power may be preternaturally excited, and determined with various effect upon the organs of organic and animal life; being so constituted as to be exquisitely susceptible to a vast variety of natural causes (§ 226, 227, 500). The muscles of animal life are naturally under the powerful influence of the nerves; this being a special ordination in relation to the nervous power and the mobility of muscles of animal life, to enable the will to determine the nervous power so as to produce voluntary motion, and other causes to render it subservient to respiration (§ 205, 208, 226, 233, 500 *c*). Hence convulsions readily spring up; while, from the nervous system being only a regulator of functions in organic life, preternatural influences of the nervous power give rise to other phenomena in that division of life. Owing, also, to these constitutional peculiarities, as well as to the natural modifications of the vital properties of the animal muscles, the nervous power, when determined with violence upon them, rarely occasions disease; while in respect to the same properties in the organic system, where they have a different modification, and the nervous power a different physiological function, it readily proves morbific (§ 133–150, 452–456).

We have, therefore, all the elements that are necessary to show that

Dr. Hall's pathology is wrong. The convulsions to which he refers as actual diseases of the spinal system, affect the muscles of animal life, upon which the will may operate with violence in an instant, or which are perpetually held in action by the nervous power for the performance of the respiratory movements, and to carry out the office of the sphincters. A slight irritation, therefore, propagated to the nervous centres may rouse these natural motions into irregular and more violent ones, without producing any more disease in the nerves or the muscles, than is produced by the operation of the will, or by those causes which maintain the movements of respiration. Again, if a cerebro-spinal nerve be irritated, convulsions are produced, and the same is done by a shock of the electric fluid. Now, these results are exactly analogous to the natural convulsions which are supposed to depend on disease of "the true spinal system of nerves." If we analyze the supposed cases, the same conclusions will follow. When, in one case, the gum is lanced down upon the tooth, the convulsions may cease immediately. In another, or when the convulsions depend on gastric or intestinal irritation, a dose of morphia, or an emetic, or an enema, or warm bath, will generally remove the convulsions very speedily, and they are not apt to return.

Diseases of the membranes of the brain or spinal cord, or of the substance of the brain or of the spinal cord itself, do not often occasion convulsions; which, indeed, are commonly independent of any disease of the nervous system. When, however, they do give rise to convulsive movements, or when such result follows an affection of a nerve, as in traumatic tetanus, there is no morbid state sympathetically exerted in any other part of the nervous system, but the convulsions are owing to a propagation of the nervous power upon the muscles as in the foregoing cases. Here, the disease of the nervous tissue is exactly equivalent, in developing the nervous power, to the irritation propagated to the nervous centres by dentition, intestinal irritation, &c. It sometimes happens, therefore, that a division of the affected nerve, in tetanus, will at once remove the spasms.

When, therefore, convulsions arise from dentition, or intestinal irritation, we apply our remedies to the gums, &c., and not to the spinal cord, or to its nerves. Such as may depend upon disease of the nervous centres, or of a nerve, are obstinate, and the treatment is then directed with a special reference to the part which may be thus affected.

Here, also, we learn the importance of an intimate acquaintance with the laws of the nervous power, and of correct theory. Convulsive movements, under most circumstances, have a very similar character; and to ascertain their causes, we must apply ourselves to other symptoms and other considerations. Nevertheless, they are apt to have certain differences in some affections. Those of tetanus have the strongest peculiarities; and here there is a very limited state of disease at the wounded part, but idiopathic tetanus may depend upon intestinal disease. But, there is often a complete resemblance between the ordinary convulsions from dentition, and gastric, and intestinal irritation, and those of hysteria and epilepsy; whatever may be the exciting causes in either case. Since, therefore, it may be of the highest importance to ascertain the particular causes, we institute a diagnosis through other attending facts.

Sympathies of Dissimilar Tissues.

527, *a.* Morbid sympathies of much intensity occur less frequently among organs of different organization than among many of those which are constituted alike, with the exception of the mucous tissue of the alimentary canal and other parts, and between the skin and other parts. Between these two organs and all others there is, on the part of the latter, the most intimate connection by sympathetic influences, especially the mucous tissue of the stomach (§ 512); and it is through this natural relation, and the increased susceptibility of diseased parts, that remedial agents so readily exert their effects upon the diseases of all organs, when such agents are applied to the intestinal canal or to the skin.

527, *b.* Sympathies between the mucous tissue of the alimentary canal and other tissues are variously considered in the progress of this work. Those between the skin and other tissues deserve farther consideration in this place. Their predominance and intensity between that organ and the alimentary mucous tissue are shown in the dependence of a vast proportion of cutaneous eruptions upon primary disease of the latter tissue. There is great reason to believe that such is the fact even in relation to measles, scarlet fever, and small-pox, when it occurs spontaneously, and probably also in the inoculated form; though, in the last case, there must be first a reflected influence from the artificial pustule of the skin upon the intestinal mucous membrane, from whence the influence is propagated back to the whole surface of the body (§ 902, *m*). This construction, so opposed to the humoral pathology, is sustained by the analogy which is supplied by most other cutaneous affections, and by the direct fact that the eruption of scarlatina and of measles appears in the mucous membrane of the throat before it does upon the skin. The eruption, especially of measles, is apt to be preceded, also, by inflammation of the mucous tissue of the eye, the nose, and lungs, as well as by cough. But, as will have been seen, it is not necessary that the secondary, or sympathetic, disease should be like the primary; especially in parts that are dissimilar (§ 527, *d*). If this pathology as to the consecutive order of developments be true, it is of great practical importance; since it assures us that great care must be bestowed upon the intestinal mucous membrane, as a principal seat of the radiating morbific influences. Hence, it is found that irritating cathartics exasperate the foregoing diseases, &c.

Other examples abound. Thus, the action of cold upon the skin is variously morbific, as set forth in a subsequent paragraph (§ 527, *d*).

Sympathies between the skin and kidneys are naturally instituted for special exigencies of the animal economy; but these organs are so constituted in their relative susceptibilities, that the great final cause of their physiological relations shall not be defeated by the propagation of morbific influences from one to the other (§ 422, and *references there*).

Sympathies between the mucous and serous tissues are comparatively rare in health, and, therefore, in disease. Since, also, the same principles, in a general sense, are concerned in the remote influences of remedial agents, we thus understand why medicine taken inwardly has so moderate an effect upon peritonitis, or pleuritis, &c.; and this

philosophy is clearly confirmed by the ready action of cold upon the skin in developing inflammation of the pleura, and by the manner in which that inflammation may be often overcome by blisters or other irritants applied to the skin. Indeed, so extensive are the natural sympathetic relations of the skin to most internal parts, that there is scarcely an inflammation of an internal tissue or organ, that may not be more or less mitigated by irritants applied over the neighboring surface, if the application be not prematurely made (§ 514, *d*).

There is a very intimate sympathy between the fibrous membranes and the cartilaginous and osseous tissues, which leads to the determination of morbific influences among them (§ 141, *b*).

527, *c*, Sympathies of different tissues with each other, of much intensity, are more common in parts that are distant, than among the tissues of one and the same compound organ.

527, *d*. When sympathies arise among different tissues, they are, as I have said, apt to be more or less different from the primary affection, or if alike, their phenomena more variable than among tissues of the same organization (§ 525). The primary affections may be mild while the sympathetic are severe. This relative mildness and intensity is constantly seen in the supervention of inflammations and congestions in remote parts as consequences of some minor derangement of the stomach, or other digestive organs, and in the manner in which severe diseases of all parts are subdued by the action of remedial agents upon the stomach. So, again, the action of cold upon the skin induces, sympathetically, inflammation of any of the tissues of the lungs, or of the intestines, uterus, liver, ligaments, &c.; but here no actual disease is produced in the skin, and the morbific agent is also of a negative nature. Hence a difficulty, notwithstanding its importance, of detecting the original source when a complex series of sympathetic affections have ensued (§ 527, *b*).

Sympathies of Individual Tissues in their Relation to each other in Compound Organs, and with entire Organs.

528. When any tissue of a compound organ becomes the seat of disease, the influence of such disease is felt, more or less, by all the tissues of such an organ, where the primary disease is at all severe; especially in the organs of organic life. The tissues, as we have seen, which are secondarily affected may or may not sustain the same character of disease as the original affection; and this will depend much upon the nature of the organ. The sympathies, for instance, between the different tissues of the lungs are far greater than between the different tissues of the stomach, and I may say, indeed, of any other organ. If the mucous coat of the stomach be even severely inflamed, the influence generally remains limited to that tissue, and will far sooner give rise to inflammation of the pulmonary mucous membrane, than it will be extended to the cellular, muscular, or serous tissue of the stomach, however much it may otherwise disturb their functions. On the contrary, however, it is quite otherwise with the lungs; especially when the cellular or parenchymatous tissue of these organs is actively inflamed, or when chronic disorganizing inflammation invades the same tissue. In either of the cases, the inflammation is apt to be propagated, sooner or later, both to the serous and mucous tissues of the organ (§ 115–117, 129, 132–155). And

here may be observed a wise ordination of Nature for the ultimate relief of so grave a disease as acute or chronic inflammation of the main substance of the lungs; an augmented secretion of mucus or serum contributing to that result, in connection with a curative sympathetic influence of the action which is necessary to those increased products (§ 74, 117, 129, 137, 155, 156, 387, 422, 524 *d*, 525). When these redundant secretions take place, the general law is, that the primary and secondary inflammations begin to abate. The salutary influence of the secondary disease, independently of the depletive effect, is seen in the frequent abatement of chronic muco-inflammation of the lungs or of the stomach, when it may supervene in one organ or the other as a sympathetic consequence of a primary inflammation of either (§ 905).

SYMPATHIES OF COMPOUND ORGANS WITH EACH OTHER.

529, *a*. Compound organs generally sympathize most readily with each other in proportion to the relation of certain functions which they may perform, and the importance of those functions, the stomach always excepted (§ 528). These groups or systems of organs have been already specified, and the sympathies to which they respectively give rise among their component parts sufficiently designated (§ 124–130 149, 150).

529, *b*. Morbid sympathies are influenced by a great variety of ac cidental causes, although they depend essentially upon the constitutional relations of the various parts of the organism to each other. One of the most remarkable is the determination which is given to sympathetic developments by almost inappreciable impressions exerted by morbific and remedial agents upon some particular part, according to the nature of their virtues, one agent ultimately involving the whole system in morbid action, or one remedy being as extensively curative (§ 149); while others, far more intense and rapid in their operation, are very circumscribed in their analogous sympathetic effects (§ 149, 150, 163). In the case of the morbific agents, where many organs are brought into sympathetic derangement, the various results may be mostly due to the action alone of a single cause, as with the miasmata of fever, the virus of small-pox, of scarlatina, &c.; or, the complex results may be greatly owing to the united action of many causes. In the case of remedial agents, their effect as to extent, intensity, &c., will depend much upon the exact nature of the pathological states.

530. Having now arrived at the end of our long journey over the enchanting paths of sympathy, I cannot but hope that they, to whom the mere physiological explorations may be new, will have gained many treasures that will adorn their knowledge, and render medicine more worthy than ever their veneration and care. An attentive survey of all the facts will assure them how far they have lived on in ignorance, how much intellectual enjoyment has been lost, how they have been beguiled into the chemical and physical doctrines of life; and, if what I have propounded of the applicability of the natural laws of sympathy to the most important problems in pathology and therapeutics be founded in truth, the realities of Nature and the substitutes of art will strike with greater force, and supply a never-failing source of advancing knowledge, a shield against the corruptions of ignorance or ambition, a guide to practical habits, and a blessing to

the sick. The physiological laws of sympathy are settled by demonstration; as well settled as the laws of gravitation, or any of the most undoubted in physics or chemistry. Such as are immediately applicable to the higher and more difficult branches of medicine, I have selected from authors who have had no such objects in contemplation, that they might come unalloyed with the suspicions attendant on theory. My attention, in this respect, has been mostly turned to the great Prussian Physiologist, by far the greatest of the age, and to the invaluable experiments by Wilson Philip. I commend them again and again to all those who would study medicine as founded in Nature, and escape the temptations which have been devised for the gratification of indolence, or for the accommodation of imbecility. We have seen it said, in high quarters, that "the time is approaching when the *foundation of practice on the laws of Organic Chemistry* will form the distinction between the enlightened physician and the mere pretender" (§ 5½ *a*, 289–292, 349 *d*–376¾, 438–448). I repeat the declaration as expressing the ascendant spirit of the age, and that all who may be disposed to encounter the threatened degradation may duly realize the importance of a firm determination to maintain their ground (§ 440, *b*).

B. *Functions especially relative to the Mental Principle and Instinct.*

531. The present subdivision of Peculiar Functions having no special relations to organic life, embraces but transient subjects for consideration in this work (§ 450). It comprehends,

1st. *Voluntary motion.*

2d. *Functions by which the mind and instinct act on external objects.*

3d. *Other mental and instinctive functions.*

532. The subject of voluntary motion has been already sufficiently examined (§ 215, 227, 232, 256, 257, 486, 487, 500).

533. The functions by which we act on external objects are performed through volition and the voluntary muscles. The philosophy is the same as in § 532.

534, *a*. The brain co-operates with the mind, and with the instinctive principle, in the acts of intellection or instinctive functions (§ 241, 500 *o, p*).

534, *b*. Although the soul be an immaterial and imperishable substance, it is so associated with the brain, that a healthy state of this organ is generally necessary to the ordinary functions of the mind, as it is, also, to those of instinct.

In a general sense, the mental functions suffer in proportion to the extent and suddenness of cerebral disease; and the same is true of the influences of the brain upon organic life. There is not always, however, a correspondence between injuries and diseases of the brain and the resulting affections of the mental principle. Apparently slight injuries or diseases of the organ will suspend or abolish the faculties of the mind, while in other cases their integrity is preserved under the most appalling affections of the brain. It is also remarkable in those cases where the mind is least affected or unimpaired, that the organic functions are apt to suffer least.—(*Med. and Phys. Comm.*, vol. ii., p. 139, *note.*)

VITAL HABIT.

535. Vital habit relates to the modifications of functions, and the variations of their results, in organic and animal life, as arising from the repeated or continued operation of natural, morbific, or remedial agents. It frequently happens, however, that the single application of a vital agent will establish this condition (§ 516 *c*, no. 6; § 545).

This simple principle is at the foundation of some of the most profound and comprehensive laws in medicine.

536. The functions of organic beings, plants as well as animals, are liable to great and more or less durable changes from the foregoing causes. I have applied the epithet *vital* to distinguish this constitutional law from those ordinary *physical habits* which are almost peculiar to man, and of which *vital habit* is a common result.

537. The functions of animal life, in man especially, are more under the influence of vital habit than the organic. The latter are variously affected, as to habit, by climate, season, food, and morbific and remedial agents, and by disease. The results of habit are most important in its relation to the groups of causes now mentioned.

538. Habit is liable to be more strongly pronounced in plants and animals by certain influences, particularly domestication, climate, and soil, than in man. Thus, as to vegetables, the ricinus communis is an annual herbaceous plant in America, while in India and Spain it is a woody perennial tree. The acquired power of enduring cold is strikingly manifested in man, animals, and plants (§ 442, &c.).

539, *a*. The philosophy of vital habit consists either in a tendency of any given condition of the vital states to remain without change, as a consequence of its duration, or in certain impressions or changes that are produced in irritability, sensibility, and mobility, in their relation to each operating cause, by which their susceptibility to the action of the particular cause or causes is diminished or increased (§ 176–215). The philosophy is alike applicable to the properties of the mind as to those of the vital principle, and, of course, to the functions of each (§ 173–176).

539, *b*. In animal life, therefore, habit concerns the senses, voluntary muscles, and the intellectual and instinctive faculties. In organic life, it refers to the organic properties and functions of every part, whether organic or animal, and takes in their sympathies, and, of course, sympathetic sensibility (§ 110–117, 201, 495, &c.).

539, *c*. Since, also, the influence of habit in either life generally relates to the particular agents only by which it is induced, we learn the advantages of interchanging cathartics, anodynes, &c. (§ 149, 163, 550). And so of the different modes of exercise, as it concerns both organic and animal life; and so, too, of the employments of the intellectual faculties, that a due improvement may be imparted to each (§ 565, 566, 855, 872 *a*).

540. The principle of habit is every where the same; always relative to impressions, more or less durable, upon the vital or mental constitution. The analogy is perfect throughout, in all its details, and is utterly subversive of every chemical or physical view of life or disease.

541. It illustrates the instability of the vital properties (§ 177–223).

542. The modifications arising from vital habit exercise an important sway in the treatment of disease; since remedial agents must be varied in kind, force, quantity, time of repetition, &c., according to the artificial modifications of irritability and sensibility, especially the former (§ 150, 188–204, 857).

543. Habit is liable to obtain under the repeated or continued operation of almost all agents which are capable of affecting the vital or mental properties. Exceptions occur in sensibility as it respects pain from injuries, and in the ordinary pleasures of sense, which are always about the same, however frequently repeated. But the pain on tasting acrids, the nausea from tobacco, &c., may cease to be produced by repetition of the causes. So, also, of the bougie, music, landscapes, the verdure of spring, &c., which are more or less variable in effect. An interval of suspension, however, in these cases, restores the original effect of the causes.

544. It is by vital habit that morbific agents, such as miasmata, cease to be injurious. This is most likely to happen, if the individual reside from infancy in the miasmatic region, or, in the unacclimated, after recovery from an attack of the miasmatic disease. Such is the philosophy of acclimation (§ 539, 551); and the same is alike applicable to tobacco, &c., and to its ultimate conversion into a luxury.

545. Sometimes the single application of a particular agent will so confirm the intensity and permanence of habit, that it becomes forever afterward inoperative. Such is not unfrequently the case with miasmata, and it is conspicuously shown in small-pox, measles, scarlatina, &c. And so of vaccination in its relation to small-pox; though repetitions of the vaccine disease may be necessary to even a temporary exemption from small-pox, while at other times the effect goes off, leaving individuals exposed to small-pox (§ 350, no. 45, 543). All this shows, too, a near identity between the vaccine and variolous diseases (§ 139, 552 *c*, 654 *b*).

546. The law of habit applies extensively, also, to remedial agents; these having the effect, by repetition, of lessening or increasing the susceptibility of organs to their respective virtues.

547. Habit, in respect to remedies, as, also, to morbific causes, demonstrates their sympathetic influences, and that they do not operate by absorption. Introduce the agents with any frequency into the circulation, the same, or greater effects, will progressively ensue.

548, *a*. The effects of habit in organic life are generally most permanent when induced by causes of unceasing and long-continued operation, such as climate, the presence or absence of light, &c. There is then some very persisting or permanent modification of the organic properties, and sometimes very remarkably of the structure (§ 74 538, 545).

548, *b*. The foregoing law is of very extensive application in the philosophy of disease, and replete with practical bearings. Its illustrations are constantly seen in the obstinacy of chronic diseases, and in the comparative inefficiency of remedies when the treatment of fevers is neglected for a single day.

548½, *a*. In a general sense, the natural vital stimuli, such as food which is of easy digestion, heat, water, &c., for obvious final causes, produce, like the blood, nearly the same impressions upon the organic properties, at every age, and at every hour, under equal circumstances (§ 136, 137).

548½, *b*. Nevertheless, certain kinds of food, and analogous stimuli, as wine, &c., come within the law of habit. This is where the kind of food may not be natural to the age of the individual (§ 568); or when it may be at first oppressive or detrimental at any age, it may become, by use, inoffensive and nutritious. During the first experiments, the food may escape the stomach undigested, having, also, irritated that organ, induced headache, &c. But, in a process of time, the irritability of the stomach becomes adapted, by habit, to the presence of that particular kind of food, its ready digestion follows, and all sympathetic results disappear. It is exactly the same law that renders tobacco, asafœtida, &c., luxuries (§ 543).

549. The law of habit, in respect to morbific and remedial agents, follows the law which governs the relative duration of disease when produced by remedial agents and such as are truly morbific. Disease excited by the former, if not in great intensity, soon subsides spontaneously; but when by the latter, it is far more lasting. This principle, also, as it relates to remedial agents, is at the foundation of their curative effects (§ 893, &c., 926).

550. Since habit subsides in various degrees, and at various times, after the removal of its causes, and the properties of life acquire, therefore, more or less, their original susceptibility to the particular agents or causes (§ 539, 543), and since the effects of remedial agents are commonly transient in respect to habit (§ 549), we may, in most cases, soon resume the suspended remedy, and obtain its original effect (§ 539 *c*, 857). And so of the causes of relative pleasure and pain, physical and moral (§ 543). In a practical sense, I am here, again, upon ground of the very highest importance (§ 516 *d*, no. 6, 558 *a*, 857).

551. Again, it is through the principle of vital habit that we must interpret the ability of the system to sustain, with the same or diminished effect, increased doses of remedial agents, as opium, tartarized antimony, &c., while this peculiarity will be limited to the agents which are thus employed. The eighth of a grain of tartarized antimony may produce vomiting at the first dose; but, by gradually increased doses every two hours, it may be sometimes raised in twelve hours, by lessening gastric irritability in relation to its own virtues, to two grains at a dose, without vomiting again (§ 556). But gastric irritability will not be thus reduced in relation to any other emetic. And so of miasmata, &c.; and I may add to § 544, that if the unacclimated pass gradually through a series of climates having gradations of miasmatic intensity, he will ultimately reach its highest virulence with far greater safety than if he plunged at once into its fury. Should, however, epidemic influences occur of an unusual nature, he will still be as much, or more exposed to their malign effects, than in uninfected countries (§ 150).

552, *a*. Other parallels hold, also, in the foregoing cases (§ 551). If, for example, the antimony be suspended for twelve hours, gastric irritability will recover its natural relation to that substance, &c. And so of the miasmatic agent, if the acclimated subject retire to a salubrious region, and subsequently revisit the insalubrious (§ 557, *b*).

552, *b*. Again, the antimony impresses the system in the ratio of its action upon the stomach, or of the duration of its action. Fever, or pneumonia, &c., will fail to be assuaged unless the gastric effect be

kept up, if the agent be employed in its small alterative doses. Or, a single dose, operating as an emetic, may at once overthrow the disease (§ 524 *a*, no. 1). And so of miasmata; since, in the case supposed (§ 551), the individual may be gradually brought under its influence, till, at last, its greatest intensity may produce an explosion of disease; or, this may ensue with great rapidity in the same subject if the gradual acclimation be neglected (§ 514 *g*, 516 *c*, 518 *b*, 557 *b*).

553. No two agents being precisely alike in their effects, habit will vary according to the exact nature of its causes (§ 150, 191, 649). Some, like antimony, often lessen irritability with great rapidity, and the property will recover its relation to the agent after a short interval of suspension. Others as frequently require a much longer time, and irritability will take various intervals of repose, often months or years, to recover its relation to these agents.

554. It is fundamental in medicine that the foregoing intervals (§ 553) are not long as it respects remedial agents, in their ordinary use, but much longer in respect to the truly morbific causes. In the case, for instance, of acclimation (§ 551), if the subject return to a salubrious climate, it may be many months, or years, before the system will have recovered its susceptibility to the miasmatic agent.

555. The foregoing exemplification of habit in respect to morbific and remedial agents (§ 554) is allied to the principle which lies at the foundation of disease, and of its cure by remedies, whether physical or moral. Disease consists, essentially, in a more or less permanent alteration of the organic properties; while remedial agents establish more transient alterations, which enables the morbid properties and actions to obey their natural tendency to a state of health.

556, *a*. Vital habit appears, also, under an aspect opposite to that of diminished irritability. It then presents itself more in the condition of a morbid change of the organic conditions. Thus, tartarized antimony, instead of reducing gastric irritability, as in § 551, may exalt it; so that, beginning with the eighth of a grain, as in the former example, but without an emetic effect, and repeating it without even increasing the dose, vomiting will take place at the second or third dose (§ 514 *g*, 516 *c* and *d*, no. 6). In these cases, we must sometimes progressively reduce the dose to the fiftieth part of a grain, or vomiting will ensue. In this particular case, irritability is also increased in its relation to ipecacuanha, and to most other irritants (§ 841).

556, *b*. This lets us into the philosophy of the most successful mode of overcoming habitual and obstinate constipation, by small doses of cathartic medicine, repeated once or twice daily; as the fourth of a grain of blue pill, and half a grain or a grain of aloes. The irritability of the intestine is thus permanently exalted, by which it is soon rendered so sensitive to the increased quantity of bile as to require a diminution or discontinuance of the medicine. The impression of each dose remains till the next is repeated (§ 514 *g*, 516 *c*, 516 *d*, no. 6). The law of increased susceptibility is brought into operation (§ 137, *d*).

What I have thus stated in this section involves some of the most important philosophy in medicine. In its practical nature it takes in a wide range of therapeutical problems, some of the most essential of which are relative to the dose or the amount of a remedy, and the proper time for its repetition (§ 857).

556, *c*. The foregoing principle is farther shown by the effect of saline and other cathartics, in promoting salivation, when given a few hours after the exhibition of a full dose of calomel. The fact was ascertained by George Fordyce, and has been often verified in my own person after the use of blue pill. The mercurial agent will not exert, in the cases supposed, this profound constitutional effect without the subsequent aid of the other agents, which so increase intestinal irritability, and that of the whole system, that the mercury operates with greater local and general intensity; a fact, by-the-way, which is also opposed to the doctrine of operation by absorption. Just so, too, bloodletting increases the susceptibility of the system to the constitutional and local action of mercury, cathartics, and many other agents, while it also lessens much their doses. A common principle lies at the foundation of the whole (§ 150).

556, *d*. Augmented irritability, sensibility, and mobility, in their proper relation to habit, depend often upon peculiar states of the stomach, on constitution, climate, &c. Hence in some climates certain remedies, as antimony, is borne much better than in others; cathartics often exalt irritability (especially of the direct seat of action) in an intense degree, &c.

But other influences in connection with the foregoing are often in operation, and may be the main cause of the effects which are, at other times, due to the causes now supposed. Thus, cathartics are liable to be surrounded by such influences, especially by increased irritability from the presence of disease, or as the effect of passion, or the play of sympathy, or the bile may be increased in quantity or in its stimulating virtues. These modifying influences may be variously applied.

557, *a*. The difference in the results of the same remedy in analogous conditions of disease often depends upon, and illustrates, the law of habit. Thus, an emetic and cathartic, exhibited near the invasion of *continued* fever, will often break up the disease; but not so if the fever have been neglected for twenty-four hours. The morbid action is then under the power of habit. On the contrary, an emetic will often remove an *intermittent* fever of long duration, if administered during the intermission. Here, the febrile action being greatly suspended at regular intervals, the force of habit is constantly broken, and nature puts on its recuperative tendency (§ 557, &c., 715, 926).

557, *b*. A special exception occurs, however, in the abstraction of blood, as it regards its remedial effects upon disease which has acquired the force of habit. In active or chronic forms of inflammation, and in fevers of considerable duration, general bloodletting, particularly, when carried to its just extent, may at once subvert the disease, or, at least, greatly cripple its force and its habitual tendency. Here, an impression is simultaneously and powerfully made upon the whole circulatory system, and that which is thus exerted upon the immediate instruments of disease is greatly advanced by reflected sympathies from all parts of the capillary blood-vessels (§ 921, 931–934). There is, therefore, a clear analogy in this case with the modus operandi of miasmata when they prove the exciting as well as predisposing cause of disease near the first moment of their contact with the body (§ 552, *b*).

558, *a*. The principle involved in § 556 embraces what is called the

cumulative effect of remedies, and of which digitalis, hydrocyanic acid, mercury, narcotics, &c., supply examples, in their small repeated doses (§ 514, *g*). And yet some of the same agents, as the narcotics, by longer use, will establish the opposite condition of habit, or that of diminished effect; thus illustrating the different aspects of the laws of vital habit.

558, *b*. In the cumulative aspect of habit, the agent, as digitalis, or mercury, or cantharides, for instance, establishes progressive impressions on the vital states, proportioned to the amount and frequency of the dose, *cæteris paribus* (§ 926). When that impression reaches a certain degree of intensity, the organic properties are brought into so full a relation with the morbific virtues of the agent, that they undergo, abruptly, a greater change; when the phenomena of full mercurial action, of digitalis, &c., take place suddenly, and perhaps with violence. The last is morbid, and exactly the same as we have seen of the progressive operation of miasmata (§ 552, *b*). But we often see manifested by digitalis, prussic acid, &c., the same variety of habit as was stated of tartarized antimony in § 551, since we must often increase the dose to maintain the original effect. And so, again, of miasmata (§ 551). This, however, is not true of some of the cumulative remedies, such as the mercurial.

558, *c*. And now, to illustrate the vital sympathetic effects of remedial agents by the process of removing the morbid effects of the foregoing cumulative remedies (*b*), we have but to interrogate the only possible manner in which we may speedily subdue those effects by other remedies.

559. Exactly the same philosophy (§ 558) is applicable to what is called predisposition to disease (§ 148, 503, 538, 539, 544, 547, 552 *b*). Nevertheless, predisposition may differ from the cumulative impression of remedies in being established by a single, and even momentary action of the morbific agent, when the organic states may go on with their morbid tendency till an explosion follows, as in § 148, 653. So, often, of a single dose of mercury in respect to its curative effects (§ 514, *g*). But, the difference lies in the greater intensity of the agent, or in a greater susceptibility of the subject to its action, or in both (§ 549, 666).

560. Another aspect of habit, as it respects morbific agents, and which goes with the rest to illustrate important principles in medicine, is the tenacity of many diseases, as shown in periodical returns of intermittent fever, at intervals of months, even after the subject shall have removed to a climate exempt from the causes. Here the original impression remains (§ 514, *g*), and frequently, also, some local form of disease, by which the general predisposition is maintained, and its explosions more or less produced (§ 148).

561. What concerns the acquired habits that appertain more or less to the constitution of all men, and which have a modifying, and often a great, influence in determining the operation of morbific and remedial agents, comes entirely within the foregoing principles relative to vital habit; and this is more obviously true of the accidental modifications of temperament that arise in individuals from the influence of climate, heat, cold, &c. (§ 78, 442 *b*, *c*, 535, 539). Where the peculiarity of constitution is transmitted from parent to child, the modifying causes have, of course, operated upon the ancestor. But the

transmitted peculiarity is equivalent to that which is generated by the direct action of the modifying agent (§ 75–80, 585, 587, 591, 659).

Here, too, we may observe how the incubation of fever, for a week or for months, is analogous to the slow progress of the artificial temperaments; though, in the former case, the remote causes may operate for an hour only, and thus establish a tendency in the organic properties to advance in their morbid predisposition, till, reaching a certain amount of change, a development of fever is suddenly displayed; while, in the artificial temperaments, the changes are commonly the result of the continued operation of the remote cause.

562. The luxuries and customs of civilized man affect his natural constitution upon the same principles as morbific agents produce disease, or as the remedial alter the properties of life back again to a state of health. In all the cases, the results are owing to impressions variously made upon the properties of life (§ 191 *b*, 535, 539).

563. So simple is Nature in her elementary laws, that the periodical desire of food, and many little usages of the body, fall, more or less, under the comprehensive law which I have exemplified by prominent instances of habit. And here, too, we glance at the philosophy of instinct in its magnificent relations to certain natural habits; and realize, also, in the phenomena, the principles which are concerned in the analogous relations of the will to voluntary motion (§ 500, *c–h*).

564. In my last proposition I was on the borders of *education*, which is mostly confined to animal life, or extended to both where animal and organic are associated in functions.

Education is allied to habit in its philosophy, as manifested both in the cultivation of muscular power and the properties of the mind (§ 175 *b*, 241).

565, *a*. Education often improves some of the animal functions at the expense of others; but this mostly where some are more the subjects of cultivation than others, as seeing, hearing, &c., or the muscular action of the arms, &c. (§ 539, *c*). When one sense, as sight, is extinct, others, as hearing and touch, become very exquisite. In the case of the muscles, mobility is augmented, and their nutrition increased; in that of the senses, sensibility.

565, *b*. A more critical analysis, in the case of the muscles, shows us that mobility in organic, and its modification in animal life, are both advanced (§ 205, 215). Hence result the increase of voluntary power and the increased size of the muscles. By this muscular exercise the function of digestion is also increased, the elaboration of bile, and important vigor is imparted to the whole organic mechanism. The principle is exactly the same as in all the preceding examples relative to vital habit.

566, *a*. This chain of exact analogies brings us to the properties of the mind, which are improved upon the same principle (§ 175 *b*, 241, 565). Here, as in the foregoing instances (§ 565), one or more of the properties is apt to be exalted at the expense of the rest (§ 539, *c*). The poet, therefore, thinks differently from the man of cultivated judgment; the lawyer is prone to sophistry and skepticism; the mathematician is wrapped in abstract truths, and deficient in practical business; the clergyman, from his well-disciplined trust in Revelation, and his scholastic habits, suffers that trust to degenerate into credulity, and too

often patronizes homœopathy, or delights in animal magnetism, or even in the anti-scriptural speculations of the geologists. The history of nature is nothing to the chemist out of his laboratory; in physiology he is like the astrologer among the stars. Shall I speak of the physician? It is said by Samuel Johnson that he is more apt to cultivate all the powers of his understanding, and all departments of nature, together, and that he has therefore been more distinguished for an enlightened and comprehensive view of the various subjects for reason than any other class of mankind.

566, *b*. And now we are prepared to comprehend the analogies between those impressions which are brought about by the habitual action of external objects upon the senses, and in which the mind is concerned, as in the satiety of spring, the increasing enjoyment of painting, sculpture, and music, and the increasing acumen with which their beauties and refinements are discerned, and, also, those other changes that are incident to the organic properties from the habitual use of tobacco, of stimulants to the nose, to the stomach, &c., or such as arise from tartarized antimony, acclimation, and those moral influences through which the black skin, the low forehead, and the flat nose, are rendered more beautiful to the African than the analogous features of the white man, or which render the flattened head, and the scarified face, an ornament to the eye of the American Indian, or the deformities of the corset, or the artificial rump, elegances in polished society, while the few that worship at the Graces' shrine become objects of dislike. The same fundamental philosophy obtains throughout.

567. From the foregoing analogies between the mental and vital powers (§ 566), it appears that the former are cultivated, through the medium of the senses and brain, and as well by external influences as by the operation of the sensorium commune, upon the same principle that the vital properties are influenced, more or less permanently, by the operation of foreign agents (§ 175 *b*, 241). The impressions in respect to mind, however, are more complex, since, in this case, they come to the spiritual part through material organs.

568. We may now see the nature of the analogies between the special injuries which result from too much or improper food in the early stages of life, and crowding the mind with study or with topics beyond its easy comprehension; and those between the ultimate adaptation of the properties of the stomach to what was once offensive, and the corresponding development of the properties of the mind and of its organs by which it sustains what had been detrimental to both, and to the general health. These principles lie deeply at the foundation of a proper elementary education of the mind (175 *b*, 548 *d*, 567).

STRENGTH, AND WEAKNESS OR DEBILITY.

569, *a*. Much of what has been now considered under the various aspects of habit is often vaguely defined by the terms *strength*, and *weakness* or *debility*. The terms are without any true meaning, and have led to very extensive practical errors. If the finger become inflamed, muscular action is impaired in the hand, or arm. This is called *weakness*, *debility*, both of the vessels which are engaged in the morbid process, and of the muscles. But, bloodletting, either general or by leeches, will cure the disease and restore muscular action.

Here the nature of the remedy contradicts the supposed philosophy (§ 743, 801, 964).

569, *b*. *Strength* and *debility* are, also, often confounded, leading to still greater confusion and error. Thus, manifestations of full muscular power are said to denote strength, while the high vascular action of inflammation is supposed to depend on debility. The former is also often seen in deplorable states of disease where debility is thought to reign supreme. On the contrary, also, the mere prostration of voluntary motion at the very invasion of disease is as constantly considered a state of debility, however exalted may be inflammatory or febrile affections upon which that contingency in animal life may depend. Tonics and stimulants, therefore, have their sway according to these supposed imaginary conditions,—imaginary, since disease consists neither in one nor the other, so far as they have any intelligible import. The designations, for the most part, are borrowed from the inorganic world; and even at this day some physiologists are making experiments upon the dead muscular tissue by immersing it in solutions of tonics and astringents, to learn the value, and the modus operandi, of those agents when applied to morbid states of the living being. Dr. Adair Crawford, for example, in his *Experimental Inquiry into the Effects of Tonics and Astringents* (1816), attributes their influence entirely to the tanning process, by which physical cohesion is established. His premises are those upon which the illustrious and able Pringle, and his compeers, rested the same conclusion; animal membranes having been immersed in various infusions, and comparisons made of their resistance to weight with the same membranes soaked in water. *Strength* was implied in the former instance.

569, *c*. If strength and weakness, or debility, be applied to organic states, it must be in a totally different acceptation from their ordinary meaning. In their vital applications, they can relate alone to any present condition of the vital powers. In this sense, the greatest strength of the body consists in a natural performance, by all the organs respectively, of the functions appropriate to each, without either borrowing from the others any assistance which it does not constitutionally enjoy, and without taking upon itself any undue amount of labor. In a state of undisturbed health, and temperate habits, the functions of all organs move on in harmony, each administering to the others a certain allotted contribution. But, in impaired constitutions, the whole of this natural harmony is more or less disturbed. Digestion is imperfectly performed, and every meal tasks the stomach beyond its natural ability. The other organs suffer, sympathetically, in consequence, and often seem to bend their actions toward a co-operative effort in aid of the diseased actions of the stomach. In this sense, therefore, all the powers of the system may be said to be unnaturally tasked. But, in the mean time, all the sympathizing organs are themselves afflicted, and just in proportion as they sympathize with the stomach. The food escapes from this organ in a half-digested state, in which chemical changes have also occurred. These changes beget acids and flatulence, and, as the crude mass traverses the intestines, it irritates, and increases the sympathetic derangement of, those organs, while these, again, reflect back pernicious influences upon the stomach and all other parts. Increased and unnatural mucus, diar-

rhœa, &c., follow in the train of intestinal symptoms, urged on by an unhealthy production of bile; while an offensive taste in the mouth, a foul breath, or a coated tongue, tell us of the sympathies which are going on in that region. The red or turbid urine shows us that the kidneys have joined in the disordered actions. The pulse may be languid, or it may beat high, according as inflammation may be absent, or have set in as one of the sequelæ; but according to the accidental state of this symptom, *the degree of weakness* is greatly measured in this complex and very common condition of disease (§ 423). But, whatever the symptoms, the system is said to be *weak*, to be *debilitated*. There is, however, no truth in this construction, as it is ordinarily understood. The powers may be all exalted; and that this is generally so, is shown by the increased secretions from the liver and intestines; while it is fully demonstrated by the nature of the curative means, which consist especially of a low diet. The supposed debility is nothing but an altered condition of the properties and functions of life, and the very remedies which the idea of debility would suggest, such as stimulants and tonics, are generally aggravating causes. Such is the exaltation of irritability, especially in the intestinal canal, that it may not bear even the stimulus of broth, nor the mechanical irritation of solid food.

569, *d*. The nearest approach to the popular sense in which debility is properly applied, consists in the exhaustion of the organic powers that attends the advanced stages of prolonged disease. (See this subject considered in § 487, *h*.)

569, *e*. Finally, I may conclude this subject with the nervous language of Southwood Smith. Even "in the intense forms of congestive fever," says Dr. Smith, "I look upon the notion of debility to be an error not less palpable in its nature, than destructive in its consequences; and if the hávoc it produces do not confer upon it a preeminence as bad as that of the very disease of which it is supposed to constitute the essence, it at least entitles it, in comparison with every other error in medicine, to the distinction recognized in society between the hero and the murderer. The one destroys a single human being now and then, but the other numbers its victims by thousands." —Smith, *on Fever*.

FIFTH DIVISION OF PHYSIOLOGY.

MODIFICATIONS OF THE VITAL PROPERTIES AND FUNCTIONS ARISING FROM AGE, TEMPERAMENT, CONSTITUTION, SEX, VOLUNTARY HABITS, &c.

570. THE differences among individuals, and classes of mankind, which arise from age, sex, temperament, &c., may be regarded in the light of qualifications of the four preceding grand attributes of organic beings.

571. Organic beings are liable not only to permanent changes in their constitution from external influences, but to others of an inherent nature. Constitution and temperament supply examples of the former; age and sex of the latter.

572. These changes (§ 571) consist in varying conditions of the properties of life, and possess, therefore, not only important relations to the physical agents of life, but modify, according to their different circumstances, the operation of morbific causes, and our therapeutical treatment.

573. All the foregoing conditions spring from the natural instability of the vital properties; and such as are brought about by external influences involve exactly the same philosophy that is concerned in vital habit (§ 177, 539). Under the present division of Physiology, however, the modified conditions are, in a general sense, of a far more permanent nature than such as I have assigned to vital habit.

I. AGE.

574. As our bodies undergo progressive changes from the time of birth to the end of life, the duration of human existence has been divided into five periods; namely, 1st. Infancy; 2d. Childhood; 3d. Youth; 4th. Adult or middle age; 5th. Old age. They mark the times during which the greatest physiological changes take place.

575. The differences which grow out of age consist in variations of the external form, and of the forms and density of the internal parts, of variations of structure, and of natural modifications of the vital properties and functions. Upon these last depend all the other changes (§ 153–155).

1. INFANCY.

576, *a*. INFANCY extends from the time of birth to the end of the first dentition.

576, *b*. At this age the fluids predominate. The organs are now softest. The bones are imperfectly ossified. The muscles small. The arteries are as numerous as in the adult, but more capacious. The cutaneous veins small, while those of the brain, and some other internal organs, are well developed. The skin warm, thin, and delicate, covered with soft hairs and underlaid with fat, which, in the adult, is removed to the internal viscera; acute in irritability, obtuse in sensibility. The eyes are large, but inobservant, resting, for the most part, on dazzling objects. The organ of hearing is imperfect and dull, and attracted only by acute or loud noises. The nose small

and irritable, sensitive in the nasal branch, but dull in the olfactory. Taste indiscriminate. Sensibility and irritability are highly developed in the intestinal canal. The teeth are making their way, one after another, till at the end of two and a half years, the first dentition is completed. Digestion and nutrition are in rapid progress, and the secretions and excretions copious. The appetite great, and returns almost as soon as appeased. The development of the digestive system keeps pace with the progress of the teeth, and when eight or ten shall have appeared, the stomach is ready for a gradual change of nutriment. The limbs are feebly controlled. Sleep is often repeated and long continued, being scarcely interrupted for the first week, even by hunger, so powerfully is the new being under the influence of its fœtal habits. Few mental impressions being made, there is no trouble from dreams. Sleep is therefore calm while the organs maintain their healthy round. It is all sleep or all wakefulness, with but little of the revery of later years. The pleasures are sensual and without alloy, but very limited. The gratification of appetite is the highest enjoyment, and hunger the greatest suffering. Judgment and reflection are in a dormant state. The mind is easily irritated, but as easily appeased; and crying is as natural and salutary as laughing at a later age.

576, *c*. The most important peculiarities of infancy, physiologically, pathologically, and therapeutically considered, are the general imperfect development of sensibility, and the greater general development of irritability, mobility, and sympathy, than at any other period of life.

576, *d*. As the diseases of infancy, like other ages, correspond with the physiological characteristics (§ 155, 156), they are not liable to be aggravated by causes which operate through common and specific sensibility; but the greater development of irritability, especially of the brain and intestinal canal, than at any other period of life, subjects the infant to a predominance of cerebral and intestinal diseases. It is owing, also, to this physiological condition of the alimentary canal that any excess of food is readily rejected by the stomach. But irritability, in being thus susceptible of the influences of the natural vital stimuli, that all its contingent purposes may be fulfilled, is especially liable to morbific impressions (§ 137 *d*, 150). It is owing to the imperfect development of the cutaneous veins in infancy, and childhood, that there is an absence of varix; and, on the other hand, cerebral congestion and hydrocephalus are now common, because the cerebral veins, and the brain itself, are large and highly endowed with irritability. Croup also prevails, and is more or less attended with a production of coagulable lymph, because of a peculiar natural modification of the organic properties of the mucous tissue of the larynx, which, changing at later periods, gives rise to catarrhal inflammation (§ 134, 135). Morbid sympathies are common and strongly pronounced, especially between the intestinal canal and the skin, and between the former and the brain. The sympathies, however, are mostly on the side of the skin and the brain, the primary affections being in the intestinal canal. Next, the lungs are liable to pneumonia, but most so after dentition begins. The appearance of the teeth is attended with some new physiological conditions, and dentition aggravates or gives rise to intestinal derangements, disturbs the natural sympathies of organs, and provokes convulsions of the voluntary muscles (§ 526, *d*).

576, *e*. Diseases being rapid and active in infancy, and injurious sympathies speedily and powerfully determined, it is obvious that remedies must be prompt, decisive, and of quick operation. But, it is also an important consideration that nature is now strongly recuperative; that the same physiological susceptibilities of infants to disease, and to its rapid advances, render them also peculiarly sensible to remedial agents, when timely and happily applied; and that they now operate speedily and with power on account of the great development of irritability, mobility, and sympathy (§ 150). Hence it is, that milder means which fail at adult age may succeed under apparently the same circumstances in infancy. An emetic, therefore, or cathartic, or alterative doses of tartarized antimony, &c., may become a substitute for a certain quantity of blood, whose abstraction in the same condition of disease would be indispensable at adult age; or leeching may be sufficient in the former case, when general bloodletting would be necessary in the latter. But, since the dangers of disease are greater, and there is less time for delay, in the diseases of infants than of adults, we should be sure of the right before we decide on neglecting or procrastinating the more vigorous treatment. This observation, however, is intended to apply especially to the abstraction of blood. Active internal remedies should be delayed in cases of doubt. On the other hand, an early loss of blood is far less likely to be detrimental; and where it may be required, but delayed, the chance of its useful application may be lost, not only through the advances of disease, but by the prostrating effects of other remedies (§ 155, 156, 925 *a*, *b*, *c*, 974 *c*).

576, *f*. It may be finally said of the characteristics of infancy, that the first few weeks of independent life are marked by peculiarities which go to illustrate the philosophy of life as expounded in these Institutes. Sleep, for example, is remarkably continued; cutaneous sensibility so dormant that injuries of the surface are scarcely felt, &c. But it is in organic life that we meet with functions that are destined for speedy modifications, of which the generation of heat is the most remarkable (§ 441, *b*).

2. CHILDHOOD.

577, *a*. CHILDHOOD extends from the age of two and a half to fifteen or seventeen years in males, and to fourteen or sixteen in females.

577, *b*. Irritability, and the other organic properties, become modified, and variously, in different parts. Those of the brain settle down into that modification which is only necessary to established functions (§ 156); or, at most, do but undergo slighter changes at the subsequent periods of life. Consequently, the brain sheds a new influence over other organs; and irritability, being less strongly pronounced in all other parts than in infancy, they are less disposed to sympathize with diseases of the brain, and of each other, or the brain with them. The digestive system has undergone manifest changes; and here, too, irritability is particularly diminished. Solid food has become indispensable, while it was inadmissible in early infancy; is less frequently desired, and can be digested only when taken at longer intervals. The secretions and excretions have lessened, as a consequence of the changes in their organic states.

Sensibility, especially specific, had made advances in infancy, and increases rapidly in childhood. The various organs of sense are turned with increasing attention to surrounding objects. This denotes an increase of perception, and with it the other mental faculties hold a progressive but more tardy pace. As knowledge pours in, the faculties of the mind increase in an increasing ratio. The organs of speech are unfolded, and there is great volubility of tongue. The skin has become less delicate, and the sub-cutaneous fat has undergone diminution (§ 440 *bb*, 440 *c*, no. 11½, 441 *c*). The chin loses its double character, and the general features acquire a contour in which that of infancy is nearly lost. They reflect the operations of the mind, and beam with enjoyment when not disturbed by the angry passions that now spring up along with knowledge and reason.

577, *c*. The foregoing new state of things gives rise to new diseases, or to new modifications of infantile diseases. Morbific causes operate according to the new modifications of the vital properties. There are new and modified circles of sympathy (§ 156, 566). New parts become the seat of disease, as the ligaments, the mesenteric glands, the lymphatic glands, the joints. Disease, too, is now apt to result in disorganization, from which infancy is greatly exempt. We have seen that some diseases become less frequent, as those of the brain. The diminution of intestinal irritability lessens the frequency and force of abdominal derangements; and this relative exemption cuts off that exuberance of sympathies which was displayed in the intestinal irritations of infancy. Croup disappears at the age of twelve. Among the new causes of disease may be reckoned the passions, and the new avenues of external influences through the senses; though the absence of grief and the predominance of hope are favorable to childhood. This is the age when severe mental labor does its worst with the constitution.

577, *d*. Remedial agents bear a general relative correspondence with the new physiological conditions, like the morbific, as we have seen of infancy, varied, however, from the latter by the modifications induced by disease (§ 149, 150).

3. YOUTH.

578, *a*. YOUTH extends from the end of childhood to the age of twenty or twenty-five years.

578, *b*. As the characteristics of infancy pass by imperceptible degrees into those of childhood, so do those of the latter gradually fade into the condition of puberty. New phenomena are alike presented by the mind and body; all springing from natural modifications of the same powers which conducted the development of the ovum through all its stages to that of the infant; which carried along the exact vicissitudes of infant life to that of childhood, and which transform the child into a being capable of procreating his species. The developments of structure go hand in hand with those of the vital powers, the latter always taking the lead, according to the ordination of the Creator; and for Whose direct Agency, as exerted at the beginning of organic life, these formative powers are designed as a subordinate substitute,—always fashioning the new being according to the original model (§ 63, 64, 155).

The most remarkable peculiarity by which youth is introduced is

the development of the organs of generation, which, as in plants, may be regarded, in a physiological sense, as the great final object of the development of all the other organs, from the embryo state; new beings being thus produced that other new ones may follow. Such, then, being the ultimate tendency of all the physical and vital developments, it obviously follows that a new condition has taken place in all the animal and organic powers at the age of puberty, and that the development of the generative organs will, in their turn, so modify the conditions of life as to carry out the design of nature in perpetuating the species.

578, *c.* Specific sensibility is now at its acme of development, and its corresponding mental power, perception, is in full and rapid operation. Knowledge of external things pours in as rapidly as the eye can glance from object to object, or the ear distinguish the tones of music as they run into each other. The mind now seizes this knowledge, and appropriates it more extensively than before to the improvement of its own powers. It compares phenomena with each other, observes their resemblances and contrasts, and as the judgment, under this exercise of reflection, acquires maturity, it deduces the great laws by which the phenomena are regulated, and finally carries them up to the very powers from which they emanate. But it does not so clearly follow, that the provision which nature has made for the right government of the mind or the body will be duly employed. No sooner, indeed, are we born, than abuses begin,—if not on the part of infancy, on that, at least, of its natural guides and protectors. The stomach is crowded with solid food, instead of its natural fluid, or when solids become appropriate, the least appropriate are often selected. The properties of life being thus abused, they suffer, and not unfrequently perish in consequence. The passions, yea, even anger, are designed for our happiness or for our protection. But judgment is permitted to fail of its legitimate sway, and the passions are let loose to fill us with disease, to imbitter our corporeal and intellectual existences, to incarcerate our bodies, or to hang us upon the gallows.

Coming to the abstract operations of mind, do we not find a like abuse of the understanding? Do we not constantly find that the knowledge which has been acquired is perverted to the worst conclusions? Are not the phenomena of nature which are opposed to each other made to assume resemblances, and such as are clearly allied equally estranged? And do we not then, by this abuse of reason, proceed to refer these incongruous results to common laws and common causes? We need not go beyond the subjects before us for an affirmative answer. Are not all the unique phenomena of life, all those which mark the distinctions between infancy, childhood, and youth, all those which attend the consummation of the body for the development of the generative organs, for the production of the ovum, of the seminal fluid, even sexual desire itself, and its ultimate termination in new beings, ay, the very thoughts which go up to Heaven, most extensively referred, at this thinking, speculative age, to the forces which rule over dead, inorganic matter? But there is a stage of human existence, which that modified materialism that acknowledges a soul has not yet dared to invade. That stage begins when both parents infuse themselves into their future offspring, when a new soul, like a new body, is generated; and it extends throughout the fœtal development. The same processes, as we have seen, are now in prog-

ress as at every subsequent stage of life. The same powers, therefore, and no others, are alike at all times the causes of the coincident results.

Returning to the characteristics of youth, we find that the testes now enlarge, and secrete the seminal fluid; the uterus becomes rapidly unfolded in its powers and structure; the menses take place; and, in both sexes, the arrangements for generation are established. While these peculiar changes are in progress, sensibility and irritability are acutely susceptible, and give rise to restlessness, impatience, and often to anxiety and distress, without absolute disease. The mammæ also prepare for the work of nutrition, swell out, and assume that peculiar rotundity which is considered the beau ideal of beauty. The beard puts forth. The face swells with blood, that the features may be supplied abundantly with the material which is necessary for their full development; and it is now that physiognomy begins to take its rank among the sciences. The muscles obtain greater firmness, greater power, and greater action. The cutaneous veins enlarge beyond their former capacity. The organs of speech undergo another change, as denoted by the hoarse and rough voice. The body spreads, becomes firm and erect, and often shoots up, in early youth, with amazing rapidity.

So much development of structure, and the institution of the generative functions, cannot fail, according to our doctrine of life, of filling the system with many new sympathies, and new diseases, or modifications of former disease. The principle, indeed, is fundamental, that diseases vary according to the natural variations that may spring up in the vital states of different parts, or of the entire body, at different periods of our existence (§ 150, &c.). These fluctuations of the natural states of the system, as also disease itself, and its very cure, as we have seen, grow out of the natural instability of the properties of life (§ 177). The natural instability, or liability to definite changes at the progressive stages of life, is not only ordained for the new physical developments that are taking place, but also for certain incidental conditions, such as gestation, lactation, &c. (§ 155, 156). Will chemistry explain?

We consequently find that the concerted action of organs is liable to be disturbed at the beginning of youth, independently of disease. The heart beats irregularly, respiration is hurried, or slow, or laborious, and fluctuates as the passions rise or fall, or as the mind may happen to poise; and the heart, and the cutaneous vessels of the face, obey the same influences. These susceptibilities may be more or less extended to all other parts, without the intervention of disease. Among these physiological results are frequent bleedings of the nose, headache, constipation, and partial disturbances of digestion. So, also, is that pain and distress which attend menstruation, and all the sympathetic influences which are inflicted upon the system at large during the progress of this excretion. It is the vital, not the chemical powers, which are thus disturbed, but not morbidly affected.

578, *d*. Where, however, nature introduces so much novelty, there must be new diseases, and new sympathetic results of a morbid character. And now mark the coincidence between the progressive development of the vital states and their liability to morbid affections. The uterus, for instance, has hitherto been merely in a vegetative

state. It has had no specific function, and its organic properties have existed only in that condition which is essential to nutrition. This organ, therefore, has been scarcely liable to any disturbance, not even of a sympathetic nature; for the organ, hitherto, has taken no part in the general operations of the body. And how clearly, by-the-way, does this illustrate the law of sympathy in its application to disease, and expose the absurdities of the humoral pathology! But, as puberty arrives, the uterus takes on its specific function; and, that this may be performed, there must be a great modification of the organic life of this organ. Agreeably, therefore, to the universal law, the uterus must be now liable to direct disease, and liable to sympathetic derangements from diseases of other organs; while primary diseases of the uterus, in their turn, develop sympathetic affections in other and distant parts. Diseases of the digestive organs inflict diseases upon the womb, and menstruation is suspended as one of the consequences. Again, when the uterus is most actively engaged, as during menstruation, it should, according to our principles, be most liable to disturbance, either from the direct operation of foreign causes, or from sympathetic influences of other diseased organs. Accordingly, even exposures to a chilling atmosphere, damp and cold feet, &c., will so disturb the uterus, when engaged in excreting the menses, as to arrest its function. And what are the frequent consequences? A long chain of sympathetic diseases, which, from the beginning of their primary cause, we might as well attempt to explain by lunar influence, or by the ebbing and flowing of the tides, as by any principle in the humoral pathology, or by any laws that rule in the world of dead matter. And yet does the intellectual world abound with physical hypotheses of life and disease for the interpretation of phenomena, of which those now under consideration are only simple elements. Now, too, the mammæ, for the first time, have their organic powers brought forth, to be in readiness for the secretion of milk. And mark, as we go along, the harmony of Design, and the coincidence between the preparation of the mammæ and that of the uterus. The development of the latter takes the lead, while that of the mammæ is the work of sympathy, and this ascendency is maintained in the pregnant state. And yet we are told that final causes should have no place in philosophy. But the mammæ, like the uterus, now, and for the first time, become the seat of morbid conditions; and, from what we have seen of their natural relations to the uterus, we readily comprehend the reason why they inflame when the uterus undergoes its sudden and violent change in parturition, and why the secretion of milk is now started, and why they are liable to diseases, such as carcinoma, which, at least, seldom occur before this organ is brought under the uterine influences (§ 138, 524 *b*, *d*). How forcibly do all such problems admonish the chemist and physical philosopher to regard all others relative to life, in its natural and morbid conditions, as a part of that great whole, of which the former are only more striking examples!

Again, the testes now, also, for the first time, have their vital state so modified as to perform their function of secreting semen (§ 155). Of course, therefore, for the first time, these organs should be liable to morbid affections, should now, for the first time, sympathize with the diseases of other parts, and inflict morbid sympathies upon dis-

tant organs. But, besides the general functions, susceptibilities, and influences in which the testes, the uterus, and the mammæ now participate in common with other organs, there are some special characteristics relative to each part that reflect no little light upon our doctrines of life and disease. The development of the testes, for example, exerts a powerful sway in determining some of the changes which are simultaneously going on in other parts, as denoted by its well-known effect upon the voice. If the parotids be invaded by mumps, the testes and mammæ are liable to inflame by sympathy, &c. The spermatic vein, also, is quite apt to become the seat of that sub-inflammatory condition known as circocele; this vein having now acquired, along with the testis, its full development of structure. And so of the cutaneous and hemorrhoidal vessels, in their relation to varix and the piles (§ 500, *n*).

From the vital developments which are in progress about the face, it is liable to eruptive affections, and the throat to inflammation. Articular rheumatism is now more rife than in childhood, and more so than at any other stage of life. If disposition to scrofula exist, it still manifests itself, as in childhood, in the lymphatics of the neck; but now, especially, it invades the lungs. This, therefore, is the age for tuberculous phthisis. The brain, having already nearly acquired its plenitude of development, and moving on in quiet stability of its organic powers, and the mental faculties employed in undisturbed operations, is comparatively exempt from disease. The passions, it is true, are now at work; but they are not of the morbific kind, either as it respects the brain or distant organs. Anger is the worst, but goes off in explosions. Envy has not been whetted. Grief is transient. Malice has not had its incentives. Avarice awaits the maturity of judgment. Hope and love hold a sway over the whole, and these are conducive to health, when love does not run into excess. Nevertheless, there are transitions from excessive hilarity to the gloom of melancholy, and the mind by fits is fanciful, and by fits is dull. But, by more than all things else, it is subject to depressing influences from the development of the generative organs, and this in proportion to its rapidity; and the state of the mind, as to its dullness, is an index of what is in progress for the procreation of the species. When the organs of generation have attained their maturity, the mind acquires its equilibrium; and its faculties, by this process, have obtained an immense accession to their vigor. These influences are alike felt by both sexes. As youth approaches the adult state, the body, like the mind, increases in vigor, and is capable of all the labor of maturer years. Now is the period for athletic exercise, and feats of strength, and now the awkwardness of youth subsides into the gracefulness and dignity of manhood.

4. ADULT OR MIDDLE AGE.

579, *a*. MANHOOD begins at the age of twenty to twenty-five, and reaches to about sixty years.

579, *b*. At the beginning of this age, all the faculties of the mind are approaching their state of maturity. "He," says Zimmerman, "who, at thirty years of age, is not an able minister, an able general, or an able physician, will never be so." The stature of the body is soon completed, its form perfected and all the organs fully devel-

oped. We have, therefore, but little novelty in disease during the age of manhood, except such as may spring from the operation of new accidental causes. The buoyant hilarity of youth is succeeded by greater steadiness of mind, tempered by sobriety and judgment. The passions are now in full operation, and those of the worst kind become more strongly pronounced; of which, avarice and envy are predominant. The disappointments and the trials of life have become manifold, and fall with their heaviest effect; and, as one succeeds another, hope is more or less supplanted by anticipation of evil. The passions, therefore, at this period of life, are of a morbific nature, and lay deeply the foundations of disease, or embarrass the operation of our curative means, and the salutary efforts of nature. Diseases of the digestive organs, especially, and their sympathetic results, are the frequent consequences of grief and disappointment. And, although the appetite has diminished, and is less frequent than at former ages, habits have become more artificial, temperance gives way to excesses, and the activity of youth yields to sedentary pursuits. Numerous arts, and the seductions of the study, call us, also, from the genial influence of the open air, and in various other ways, contribute morbific influences.

Most of the injurious tendencies which are superadded to the age of manhood beset, in the first place, the organs of digestion; dyspepsy being one of the most frequent forms in which disease is now presented, and carries in its train a multitude of sympathetic evils. It is not, however, till the age of thirty-five that these manifestations become common, unless the foundation have been laid, as is frequently the case, by violations of nature in childhood or in youth, or by transmitted predisposition. This is also the period of pregnancy; and, although a natural condition, the artificial habits of society have so modified the natural state of the system, that pregnancy, parturition, and the period of nursing, give rise to no small amount of disease. For the same reason, also, menstruation is often interrupted, while this interruption deranges other organs. Owing, in no small degree, to these acquired peculiarities and the diseases of women, midwifery has become a distinct and important department of medicine. From forty-five to fifty, menstruation ceases, and with it the period of childbearing. This new change in the uterus is apt to develop sympathetic disturbances in other parts, and to become a cause of disease in the uterine organs. But, as a compensation, there is now an exemption from those maladies and that suffering which result from the menstrual function.

From the age of 45 to 70, the cerebral veins take on that peculiar modification of congestion which results in a secretion of blood, and which, as occurring in the brain, determines the common form of apoplexy. This condition decreases toward the age of 70. But, I shall not dilate farther upon the peculiarities of this era of life, since they are all referable to the great principles which govern the characteristics of every other period, and all require the same considerations in the aspects of pathology and therapeutics. As at all other stages of existence, also, the characteristics of manhood are gradually changing till they are finally blended or disappear in those of old age.

5. OLD AGE.

580. The last period of life has been subdivided into *incipient* or *green old age*, which extends from 60 to 70; *confirmed old age*, or *caducity*, from 70 to 85; and *decrepitude*, from 85 years, upward.

581, *a*. More remarkable changes now take place in certain parts of the organization, than from the beginning of youth, upward; but, as they occur not in the essential organic parts, modifications of the organic properties and functions are less the cause of certain prominent phenomena than the physical deviations in comparatively unessential parts; such as ossification of the cardiac valves, of the arteries, &c. The senses are failing as an avenue of knowledge. The eye becomes dim, and the ear is only arrested by acute, or distinct, or loud noises. The motions of the body are slow, the back stiff, and more or less curved. The intervertebral cartilages, also, shrink, and the stature lessens in consequence. The joints and tendons become rigid; the sutures coalesce; the skin is darker and more wrinkled; the fat retires from the circumference to the internal organs, by which the superficial veins are rendered more prominent, and the eyes sunken.

581, *b*. Nevertheless, rigidity and other changes go on in the most essential organization, which are principally characterized by a natural decline of the vital properties and functions; but none are abrupt, and there are no new functions introduced, and none are arrested. All these new conditions, too, as at all other stages of life, are the work of the organic properties,—always creative, but ultimately giving rise to physical changes of a suicidal nature, and which end in their destruction. Irritability and sensibility are, therefore, upon the wane, and mobility is alike embarrassed by the foregoing physical changes.

581, *c*. The mind, too, in ordinary cases, is going with the organic powers; but it is worth observing, as a characteristic distinction between the soul and the organic properties which animate its abode, that genius rarely wears out. It sparkles as bright as ever, when the flickering lamp of life is but dimly seen.

581, *d*. The decline of the mental powers is accompanied by a subsidence of the passions; and as sensibility also fails, former morbific causes and avenues to disease are thus greatly diminished.

581, *e*. The old man waits his certain doom in calm serenity, or only impatient for its approach. He is satiated with the pleasures of life; perhaps because he can enjoy no longer. His reminiscences are rather of his pains than of his delights, because the former are more indelibly established, and are not now counteracted by present enjoyments.

582. From what we have now seen of the physiological conditions of old age, it is evident that diseases vary but little from those which prevail after 40 or 45 years; only from the gradual embarrassments sustained by the organic powers, disease is apt to be less violent, while, also, for the same reason, there is less of the recuperative ability. Apoplexy, palsy, organic affections of the heart, and urinary difficulties, are the predominating accidents of old age.

583, *a*. Although, therefore, morbific causes are less energetic in old age than at other stages of life, remedial agents are, also, less op-

erative, nature less recuperative, diseases less easily arrested, are sooner beyond the reach of art, and often eventuate suddenly in death, without having attained any degree of severity. Life often snaps when the old man is quaffing his wine, or as he "shoulders his crutch to show how fields were won."

583, *b*. Hence it is apparent that remedies must be prompt and efficient in proportion to the exigencies of disease; as is more extensively set forth in the article on Bloodletting.

584, *a*. Finally, it appears from the characteristics of life at its various stages; the progressive variations in the vital states; the successive developments of important organs; of the new functions which are instituted and again extinguished; till we come to that period when the properties of life lay the foundation of their own ruin by instituting disorganizations of structure; and from what, also, we have seen of the corresponding modifications of disease at the various eras, and of the new ones which appear, with their new train of sympathies, it is obvious, I say, that there must be some corresponding variation of treatment which may be relative to a common character of disease (§ 117, 134–160). But, at every varying stage of life, all things proceed upon established laws; and, however modified the powers which may be in operation, and by which every result is brought about, and whether so by nature, or by morbific causes, or by art, there are precise laws by which all the phenomena are determined according to the particular combination of existing circumstances. It is an important object of art to find out all the conditions which may attend any given state of the properties and functions of life, whether natural or morbid, that the most appropriate regimen may be adopted, or remedial agents be applied with the greatest precision.

584, *b*. Every remedy would always operate in one uniform way, were the conditions of the vital properties and functions, and the structure which they animate, always the same; just as the blood always affects the heart and vessels in one uniform manner, in health. But, such is the instability of the properties of life, and such, in consequence, the variableness of morbid conditions, that these modifications are rarely precisely the same in any two instances, or at any two successive days. To find out these varieties, and to adapt accordingly the general principles of treatment, and in their relatively specific details, is one of the highest and most difficult aims of medicine; and demands, as an indispensable qualification, a profound knowledge of the philosophy of life.

II. INDIVIDUAL AND GENERAL PECULIARITIES, CONSISTING OF TEMPERAMENT, CONSTITUTION, IDIOSYNCRASY, AND NATIONAL ATTRIBUTES.

A. *Temperament, Constitution, Idiosyncrasy.*

585, *a*. Under our fifth division of physiology we have next in order the *Temperaments*, &c., or those peculiarities of life which naturally distinguish one individual from another. The temperaments, therefore, may be regarded as embracing the innate as well as acquired peculiarities of constitution; for, although the latter depends upon causes that are relative alone to the individual, the former, or innate constitution, has been brought about, at some anterior genera-

tion, by the physical agencies of life. This is the true temperament, and belongs to masses of mankind.

585, *b*. *Idiosyncrasy* is only a variety of temperament and constitution, and like those, therefore, depends upon some peculiar modification of the properties of life, especially irritability; but only so in relation to a very few particular agents. It is peculiar to individuals, rather rare, and may be hereditary or acquired. This peculiarity is not unfrequently the cause of the favorable or deleterious effects of certain remedial agents, of certain kinds of food, &c. We see the important principle illustrated every day, every hour. Here is a subject who is salivated by the external application of a few grains of mercurial ointment, and in whom syphilis, or fever, may be speedily extinguished by this simple use of the remedy. But here is another, in whom the internal administration of an ounce of calomel may produce no constitutional result, and make no impression upon syphilis. Or, it may be in another case of extreme susceptibility to the action of mercury, that the agent always displays the effects of a profound poison, aggravating fever and syphilis, or, in the absence of disease, greatly deranging all the functions of life. Most men are poisoned by the slightest contact with the rhus vernix; but now and then an individual handles it with impunity. Muscles, and some other animals, are always poisonous when eaten by some people, though generally good articles of food.

585, *c*. *Constitution* comprehends all the peculiarities of the individual,—the temperament, idiosyncrasy, conditions relative to age, sex, habits, &c. It is therefore liable to many variations at all periods of life. The prevailing characteristics of each of the elements may remain, but yet so modified that what is known as constitution may be "broken down."

585, *d*. The same principle is concerned throughout, whether in respect to *constitution*, *temperament*, or *idiosyncrasy*. It is the same as prevails habitually in respect to the naturally modified irritability of different organs in man, and in all animals, and in plants; that which renders urine innoxious to the bladder, but morbific to all other parts,—that which renders the eye susceptible to the undulations of light, the ear to the undulations of air; and so on (§ 133–159). The principle, and its everlasting, unchanging laws, are every where, in all that relates to organic beings, whether in respect to the system in its abstract condition, or as relative to external agencies. It is a great and wonderful principle, a perpetual study for the philosopher, ever pregnant of variety, ever illustrative of the peculiar character of the properties of life, of their natural modifications, of their instability, and forever supplying fresh sources of interpretation of the laws which the properties and actions of life obey.

586. It is evident, therefore, that temperament, constitution, and idiosyncrasy, are constituted by certain acquired or transmitted conditions of the vital properties, which form a part of the natural or habitual state of each individual, and from which arise various degrees and kinds in the susceptibilities to the action of physical agents, and certain peculiarities, also, in the material condition and conformation of parts, especially the external. By studying these sensible peculiarities, as well as the phenomena of life in their natural and morbid conditions, we infer the peculiarities of the natural vital conditions in dif-

ferent individuals, or their natural constitution and temperament, or any more remarkable idiosyncrasy. They reach, also, to the mind, which is apt to bear certain relative peculiarities to those of the organic states.

588. In the farther consideration of this subject, I shall regard those peculiarities of constitution which are mostly of a determinate nature, and include them under the general denomination of temperament.

589. The philosophical differences between temperament, idiosyncrasy, and constitution, are neither great, nor of much practical importance. Indeed, so allied are they in principle, that a common philosophy determines the remedial treatment, which is always more or less modified by temperament. Each should be considered along with the modifying influences of habits, climate, &c.

590. Temperament and constitution do not depend, as supposed by some writers, upon the special development of particular organs; though this is true of some of the vicissitudes of age (§ 153–159, 596). The former have their foundation in the system at large, and are apt to be transmitted by one or both parents; or the transmitted peculiarities may come from a remote ancestor, and not from the immediate progenitor. This last peculiarity is analogous to one of the characteristics of the scrofulous diathesis, where it passes over one generation and reappears in the third.

591. It appears, therefore, that temperament, whether innate or acquired, is due to the slow operation of causes upon the vital constitution; just as we have seen of the law of *vital habit* (§ 535–568). In the latter case, the modifications are more or less transitory; but may be so ingrafted as to be transmitted, for a time, like the permanent temperaments, from parent to child, as seen of some diseases, such as lues, or of predispositions to disease of a transient nature, as in small-pox, or even ordinary fever. Coming to hereditary disease of a permanent nature, as scrofula, we run from the transitory phenomena of vital habit, by an intimate analogy, into the permanent temperaments; and from these we are conducted by the same philosophy, which respects the operation of physical agents in modifying the properties of life, to those more remarkable peculiarities which spring up in animals from domestication, and in plants from changes of climate and soil (§ 75–80, 143–147, 220, 327–331, 559, 561–563, 659, 666 *b*, 674).

592. It is scarcely probable that differences in temperament have, often, any appreciable effect on the elementary composition. Differences, however, obtain in respect to structure, as seen in the general form, the proportions of the limbs, the features, &c.; while more remarkable corresponding analogies are witnessed in the herbaceous and arborescent habits of the same plant, as it may be subject to the influences of a tropical or cold climate, as the ricinus communis (§ 538).

593. Great differences arise not only in respect to the influences of the same remedial agents from the mere circumstances of temperament, but morbific causes may be equally various in their operation. The same causes may also be very apt to affect one temperament, while they will rarely have an effect on another temperament (§ 142, 145, 740).

594. The temperaments, as designated by the ancients, and retained by the moderns, are divided into the *sanguine*, the *melancholic*,

the *choleric*, and the *phlegmatic*. The artificial habits of the moderns have added a fifth, or the *nervous*.

595. It is not usual to find all the attributes of each temperament united, while some of the whole may be blended in the same individual. Nevertheless, the characteristics of one or another generally predominate.

596. Temperament is most distinctly pronounced at adult age, after the influences of development have ceased (§ 590).

1. THE SANGUINE TEMPERAMENT.

597, *a*. Unlike the other temperaments, the characteristics of the *sanguine* are perpetuated from infancy, and perhaps, therefore, may be considered the most natural. The skin remains soft and delicate; the limbs rounded and full; the superficial veins, unlike those of infancy, large, conspicuous, and blue, especially about the head and temple; the complexion fair, florid, and animated; the eyes large and blue; the hair light, or red, or of intermediate hues.

597, *b*. Sensibility and irritability are strongly pronounced; the great development of the latter giving the principal determination to the sanguine temperament. The blood, in consequence, stimulates the heart to more frequent, high, and regular action, maintains the capillaries in a lively and plethoric state, and thus determines the redness and softness of the skin. Other vital stimuli also operate with greater intensity than in other temperaments. For the same reason, the secretions and excretions are rapid and copious, and are little liable to vacillation, in the ordinary conditions of health. All things else move on in a corresponding manner; the whole assemblage of which beautifully illustrates the true philosophy of life.

The great development of sensibility contributes, also, its considerable part to this temperament. The senses are ever on the alert; and here, as with irritability, external objects make their impressions with great effect and rapidity. Perception is rapid, reflection quick, imagination lively, memory prompt. The succession of ideas is too rapid for comparison, and hence the judgment is infirm, unless associated with genius; when it is distinguished for eccentricities. This is exemplified in the poet, Byron, and in the warrior, the Marshal Duke of Richelieu,—"that man, so fortunate and brave in arms, light and inconstant, to the end of his long and brilliant career."

597, *c*. Inconstancy and levity are the great moral attributes of the sanguine. Variety and enjoyment never satiate. Devoted to sensual gratifications, they are in love with all female beauty, and are inconstant to a mistress, if not to a wife; yet are they honorable in all things else. It has been said of Newton, that he was of the sanguine temperament; but, had he been so, it is replied, "he never would have carried, as he did, his maidenhead with him to the grave, at the age of fourscore." Nor do the senses afford that leisure for profound meditation, nor admit of those intellectual operations which are indispensable to the mathematician and astronomer; whose habits, also, are more adverse to this than to any other temperament.

The sanguine is eminently generous or prodigal, and the end of gain is the purchase of pleasure. Quick in anger, he is soon cool; or he is impelled to hasty decisions that are soon regretted. A challenge to a duel would be gladly abandoned, did not a sense of pride

urge him on to the combat. Revenge and envy have no hold upon this constitution.

597, *d*. It is evident, therefore, that the prevailing diseases of the sanguine temperament are active and inflammatory; that the organs sympathize readily and greatly with each other, and that the sympathetic affections are disproportionately greater than the primary affections. Infancy always partakes of this temperament; but if it be truly constitutional, the infant is liable to extraordinary demonstrations of its fundamental nature. The irritation of a tooth, for example, is more apt to produce convulsions, and intestinal derangements still more so, or to lay the foundation of cerebral disease, &c. At adult age, slight disturbances of the womb bring on hysteria, or indigestion contributes to a more sudden accession, more violent phenomena, and a more rapid progress, and lights up the flame of other diseases more speedily, and more violently, than in other temperaments. Anger, being quick and vehement, here displays its instant effect in developing inflammations, and hemorrhages. But love is too instable to undermine the health; and as envy, grief, and jealousy, torture not the mind, so do they not the body.

597, *e*. As external causes, whether natural or morbific, make their impressions rapidly and profoundly upon the sanguine temperament, and its diseases being active and violent, remedial agents should be prompt, and decisive, as in infancy; but here, also, for the reasons which are relative to the first period of life, and for such as are assigned in section 597 *b*, remedies are also profound and speedy in their operation. And since the prevailing disease of this temperament is inflammation, bloodletting is the principal means of cure, and will require but little co-operation from other agents. If early applied, and carried to its proper extent, it will often nearly extinguish the most violent inflammations during its first application. The test of this extent will be also more exactly determined in this than in other temperaments by the subsidence of symptoms during the progress of the operation. It is in this temperament, also, that the philosophy of the vital influences of loss of blood is most evidently shown (§ 191).

2. THE MELANCHOLIC TEMPERAMENT.

598, *a*. The *melancholic temperament* has certain points of resemblance to the sanguine, though they are strongly contradistinguished. The general external aspect of the latter is cheerful; that of the melancholic, dry, stern, or gloomy, and excites no liveliness in others, though it command respect and even admiration. The solids predominate in the melancholic; the capillaries show less blood, though the veins are large and more prominent, but less transparent than in the sanguine; and, unlike the latter, the skin is darkish, or inclining to yellow, thick, coarse, and hard to the lancet. The blood flows more freely from the sanguine when the skin is pricked; and this exemplifies the state of the capillary circulation at large. The same principle obtains, therefore, in the pulmonary circulation, and hence, in part, the blood is darker in the melancholic than in the sanguine. The eyes of the former are darker and less prominent than in the latter; and the hair is dark, coarse or stiff; eyebrows large, black, and often projecting; the muscles and tendons, like the superficial veins,

stand out, from the absence of that cutaneous fat which gives rotundity to the body of the sanguine (§ 440 *bb*, 440 *c*, no. 11½, 441 *c*).

598, *b*. It is easily seen, therefore, that irritability and sensibility are comparatively dull in the melancholic. External objects do not make the strong and rapid impression upon the senses as in the sanguine; and, from the obtuseness of irritability, the action of the heart is slower, the capillary blood-vessels are less charged with the vital fluid, the secretions and excretions less, and more slowly performed (§ 191).

598, *c*. The melancholic temperament is the principal abode of genius; embracing a large proportion of those great men who have unfolded the laws of nature, or have made the highest advances in the arts, or have astonished the world with deeds in arms, or with the achievements of the statesman, or the orator, or the painter, or the poet. The melancholic is the man of men. I had almost said, in moral constitution, he is perpetuated, unchanged, from the model of his race. Here is witnessed the highest intellectual renown at the very dawn of manhood; and here it is that we so often meet with genius struggling with those adversities which arrest the ambition of other temperaments. The melancholic is forever indomitable; rising in determination as obstacles rise before him. Inflexible in purpose, the passions are disciplined to urge on an arduous enterprise, or if allowed to become impetuous, it is to accomplish the decisions of the understanding. With equal facility he concentrates his mind upon abstract inquiries, or at the next moment sends it abroad over the widest theatre of its operations. He is bold and brave, never fearing death, nor wantonly incurring danger. He moves steadily forward, though he does not move till the path before him has been explored. His imagination, therefore, is of the highest order, being disciplined by the sterner faculties. It is such an imagination as is always an element of genius; such as contemplates the realities of life and the truths of Revelation. He is thoughtful, grave, or sad, but may tune his mind to great elevation and great sublimity and enthusiasm, and often soars on poetic wings through the regions of Heaven. The sanguine, on the contrary, delights in the romance of fiction.

Honor holds its empire in this temperament, however it may be wanting in human sympathies. If pledged to a good or a bad action, it is fulfilled. The melancholic is generally fervent but dignified in his attachments, or looks with indifference or with scorn upon humanity. A few, like Tiberius, are fearful, perfidious, suspicious, and cruel; and others, like Nero, or Richard, insensible to danger, and ever ready for the work of death.

598, *d*. As with sensibility and irritability in their natural aspects, so is it in their relation to morbific and remedial agents. The coincidence is universal. The former are slow in establishing morbid changes, many are inoperative which readily light up the flame of disease in other temperaments; and the passions, a prolific cause with others, are subdued by the melancholic into mere agents of the understanding. But when morbific causes have made their impression, the dullness of irritability and mobility explains why disease is apt to be obstinate, and why remedial agents operate with less rapidity than in the sanguine. The vital properties and functions being slowly susceptible of morbid changes, they are slowly altered from their morbid states (§ 150, 191).

It is easily inferred that the diseases of the melancholic are mostly of the digestive organs, and that their removal is tedious. It is also manifest that these, and other affections, are slow in developing diseases of other parts, and that the brain and the mind must be most likely to sympathetic disturbances. Hence it is that hypochondriacism and insanity are apt to supervene on the melancholic temperament.

Cathartics are demanded more by the melancholic than by any other temperament; though their exigencies have a special relation to the disorders of the digestive functions. Bloodletting, also, is often necessary to reach these chronic maladies; and, although its delay in the grave forms of inflammation be less hazardous than with the sanguine, its necessity is as great, and its extent and frequency of repetition are greater. It is here, too, that the greatest demand is made upon the materia medica for auxiliary means.

3. THE CHOLERIC TEMPERAMENT.

599, *a.* The *Choleric* is intermediate between the sanguine and melancholic temperaments; and although it form the sanguineo-melancholic, it possesses characteristics which give to it an individuality.

The skin has greater fullness of the capillaries than in the melancholic, and therefore greater softness, and warmth, but less than in the sanguine. The pulse is intermediate in fullness and frequency. The secretions and excretions moderate and uniform; the healthy functions performed with regularity and ease.

599, *b.* The passions are easily roused, though not impetuous, and therefore less transient and less easily appeased than in the sanguine, though not so persevering as in the melancholic. The choleric is tenacious of his own rights, but less disposed to infringe upon the rights of others than the melancholic, while he has less generosity than the sanguine. The higher faculties of the mind correspond with the other characteristics of this temperament, being generally distinguished for their moderation.

599, *c.* Irritability and sensibility holding an intermediate degree between those of the sanguine and melancholic, external agents operate with a relative effect and rapidity; so that the organic functions move on without frequent or profound interruptions, and diseases yield to a more compound treatment, though less readily than to the simpler means required by the sanguine, but more speedily than in the melancholic.

4. THE PHLEGMATIC, OR LYMPHATIC TEMPERAMENT.

600, *a.* The *Phlegmatic* is characterized by slothfulness of mind, and by a simpler display of vegetative life than any other temperament. The flesh is soft, the countenance pale, the hair delicate, and the fat amounts to an encumbrance. The limbs are rounded, feeble, and without expression. The veins are small, and lie deep. The pulse is small, feeble, and soft; arteries small, and the capillaries deficient in blood. Irritability is dull. The secretions and excretions are performed slowly, and their products are thin or watery. Sensibility is also obtuse, and perception weak, which greatly circumscribes the senses as an avenue to the mind; while

"Fat holds ideas by the legs and wings"

(§ 440 *bb*, 440 *c*, no. 11½, 441 *c*).

But, with all the intellectual dullness and bodily indolence, which distinguish this temperament, it is obstinate, fearful, suspicious, and avaricious.

600, *b*. The organic properties of the phlegmatic are easily liable to interruption, though morbific causes, unless intense in their nature, make their impressions feebly. The mind, and its predominant passions, have, of course, but little agency in the production of its diseases. Disturbances, however, seem to arise from the mere inertia of the vital powers; and when morbific causes make strong impressions, the properties of life often go down at once to near the verge of extinction. So, also, do active remedial agents operate with a relative effect. Emetics are scarcely admissible; violent cathartics prostrate excessively; and any unnecessary extent of bloodletting breaks down the whole energies of the body. This temperament, therefore, requires great moderation of treatment (§ 150).

5. THE NERVOUS TEMPERAMENT.

601, *a*. The *Nervous temperament* displayed itself feebly among the ancients, but has been brought to a high maturity by the progress of civilization. It is the only temperament where the primary causes may be traced, which consist mainly of such as are attendant on indolence and sedentary pursuits. It involves alike, therefore, the rich and the poor, the sensual devotees of fashion and the plodding shoemaker, the laborious student and the readers of romance.

601, *b*. The nervous temperament is founded upon the sanguine, or the sanguineo-melancholic, and is either transmitted, or springs up originally in the individual. It is therefore the most artificial of all the temperaments, and is susceptible, individually, of great improvement. It is shown externally by a general aspect of feebleness, a spare body, and small, soft muscles, which are incapable of much exertion.

601, *c*. An unusual predominance of sympathy is the leading characteristic. Irritability is also strongly pronounced. Hence, slight disturbances, even of unimportant parts, give rise to greatly disproportionate sympathies in the more important organs; and these secondary results will be still more intense if the primary disease be seated in any important organ.

The functions are constantly subject to irregularities, especially those of the abdominal viscera. If the subject be addicted to the causes of this temperament, he is rarely free from indigestion, and an attendant train of other evils, according to the nature of his indulgences or pursuits. Diseases, however, are not as violent as with the sanguine, nor as profound as with the melancholic. The mind is irritable, but the passions not violent, though they readily disturb the organic functions. Such as display themselves depend much upon the habits and occupation of the subject.

601, *d*. Remedial agents operate with power; the same coincidences existing between their effects and those of a morbific nature, as in other temperaments. Moderate impressions, therefore, made upon the intestinal canal are sensibly felt by remote parts; and in this temperament, particularly, the peculiar principle upon which leeching operates is well illustrated (§ 145, 147, 914, &c.).

General Remarks on Temperament.

602, *a*. Different epochs of life appear often to partake of a particular temperament; one subsiding into another. The sanguine is most characteristic of infancy and childhood; the melancholic and choleric of middle age; and the phlegmatic of old age.

602, *b*. The several temperaments are also often blended, more or less, with each other in the same individual, though the characteristics of one generally predominate. When combined in the same individual, they are called the sanguineo-melancholic, the sanguineo-phlegmatic, &c. They are also liable not only to the foregoing modifications from age, but from sex, climate, habits, education, &c. So great, indeed, is the influence of climate, that a change of residence (as from a northern to a tropical country) will sometimes gradually transmute one temperament into another; and this is particularly true of the sanguine, the melancholic, and the choleric.

602, *c*. The foregoing accidental influences are sometimes such as to generate anomalies, in which it is difficult to recognize any distinct features of the prevailing modifications of temperament, and which may disappear with the individual, or be transmitted to his descendants.

602, *d*. All the varieties comprehended in this section are more or less liable to modifications of a common form of disease, and require corresponding variations in the details of treatment. They concur together, therefore, in forming a part of the difficulties of medicine, and in demonstrating the complete abstraction of organic beings from the forces and laws of the inorganic (§ 655).

603. I say, organic beings in their most comprehensive sense (§ 602, *d*). For are not the varieties which have sprung from domestication, and cultivation, among animals and plants, and which are equally, and more perfectly transmitted than temperament, constitution, &c., in relation to man, integral parts of a common principle? Exactly the same philosophy lies at the foundation of the whole, and is another broad field of evidence to substantiate the unity of the Vital Principle, of its common laws and functions throughout animated nature, and presents the whole in a magnificence of Grandeur, a Harmony and Unity of unfathomable Designs, which stamps an unutterable contrast on the confusion and imbecility of the chemical and physical hypotheses of life. (See *Climate*.)

B. *Races of Mankind.*

604. Corresponding, in principle, with Temperament, &c., though different in their manifestations, are those peculiarities which have distinguished mankind into various *Races*. They correspond more nearly, in the physical characteristics, with those sensible changes which are established by the domestication of animals, and by the cultivation of plants (§ 603). As with many species of the latter, the varieties of mankind have existed without change as far back as history begins its record. This circumstance has often led the speculative mind to imagine as many original ancestors as it may distribute the human species into varieties of race (§ $350\frac{3}{4}$, *kk*). But, with exactly the same reason may we assume that the black and the white barn-yard fowl, and all the other varieties of this animal, or the red

and the white potato, and other varieties of this root, the sloe and the plumb, the crab and the apple, are equally distinct, and that each has descended from a distinct original progenitor. Or take the yet more remarkable transmutation of a salt and bitter weed into the varieties of the cabbage and cauliflower, by transplanting them from the sea-shore into the rich mold of gardens, and which are as dissimilar as each from the original species.

605, *a*. The attributes of Race are mostly of a physical and moral nature; and, unlike the temperaments, but analogous to the foregoing varieties of animals and plants (§ 604), they are not attended by any special modifications of the properties and functions of life; but all the races are liable, individually, to the physiological conditions of temperament. The general attributes, therefore, admit of no physiological, pathological, or therapeutical applications.

605, *b*. And here it is worthy of remark, as illustrative of the common nature of the properties and functions of life, that other changes to which animals and plants are liable from unaccustomed physical agents are attended by distinct modifications of their vital states, and remarkable variations of structure. An animal, for example, transferred from the tropical to colder regions, undergoes a change in its hairy or woolen vesture, or from summer to winter in the same climate. The tree, transplanted from the tropics to a northern latitude, may be made to resist the inclemencies of winter, and finally puts on a denser bark, and a hibernaculum for its leaf and flower-buds. Or yet more strikingly, what is herbaceous in equatorial regions may become a shrub or a tree in temperate climates. These mutations, therefore, are strictly analogous to the temperaments of man. Or, again, what is more emphatically characteristic of the analogies of nature in any of her grand departments, consists in the fact that the varieties which are constituted by hybrid animals and plants are, equally with the foregoing, both in respect to cause and effect, corresponding phenomena with the varieties of temperament.

606. From what is known of the analogous varieties among different species of animals and plants (§ 604), we shall have little difficulty in referring the characteristics of race to the influence of physical agents upon the properties of life; and of these there are none so obvious as climate. Like temperament, &c., the whole falls under the laws of vital habit (§ 535, &c.).

607. Perhaps there is no better classification of Race than Lacépède's; who reckons only the European Arab, the Mogul, the Negro, and the Hyperborean. These have been variously subdivided.

Blumenbach's division of the races is also simple and just; namely, the Caucasian, the Mongolian, the Ethiopian, the American, and the Malay. The Caucasian variety answers to the European Arab of Lacépède; the Mongolian to the Mogul; the Ethiopian to the Negro; the American embraces all the natives of North and South America, excepting the Esquimaux; and the Malay includes the inhabitants of Sumatra, Borneo, New Holland, and many other islands of the South Sea; most of whom speak the Malay language.

608. The European Arab comprises the people of Europe, Egypt, Syria, Arabia, Barbary, Tartary, Persia, the North American Indians, &c.

The fundamental characteristics are an oval face from forehead to

chin, a prominent skull anteriorly, a long nose, skin more or less white, and long, straight hair.

609. The Mogul race is composed of the Chinese, the inhabitants of Eastern India, Tonquin, Cochin China, Japan, Siam, and the South American Indians. This race is more numerous than all the others. Its characteristics are a flattish forehead, eyes turned rather obliquely outward, cheeks prominent, oval face between the two cheek bones.

610, *a*. The Negro, a native of Africa, possesses the most perfect characteristics. The black skin, the low, flat forehead, the depressed nose, the thick lips, the woolly hair, the dullness of understanding, and the acuteness of his senses, mark him as the greatest phenomenon among the physical changes of our species. This is the only race of whom it can be surmised that the change has been miraculous.

610, *b*. The bondage to which the Negro has been subjected has naturally excited the sympathies of the humane, and has led them to assume in his behalf an ideal rank in the scale of mind. I would not oppose this harmless prejudice were it not in collision with fundamental laws which it is my duty to interpret, as far as may be, as nature teaches. The brain has undergone in this degraded race (degraded as well by nature as by man) a large extent of that mutation, which, in a far inferior degree, stamps the white man with intellectual imbecility. But, degraded as is the Negro in mind, in body, and in bondage, he is yet a man, and, like the rest of the human family, descended from common parents. His very imbecilities, therefore, entitle him the more to our sympathies and protection.

611. The Hyperborean stands, also, in strong relief from the rest of mankind. This race comprises the Laplanders, the Esquimaux, Samoiedes, Ostiacs, Tschutski, &c.

They have broad faces, flat features, swarthy skin, and are stinted in growth. In the scale of intellect they rank next above the Negro.

III. SEX.

612. Certain physiological differences in the sexes appear to have been impressed originally upon the constitution; and this, indeed, was necessary to the perpetuation of the species. But, although our first parents were created in a state of maturity, this has no bearing upon the physiological developments that may be in progress during natural growth, and which are designed to conduct the individual to that mature condition in which he came from the Hands of the Creator.

613. Besides the special difference in the organs of generation, woman is of a lower stature than man, less rigid in organization, softer and more delicate in her skin and complexion, abounds more with cutaneous cellular tissue and fat, (§ 440 *bb*, 440 *c*, no. 11½, 441 *c*), which gives greater rotundity to her limbs and greater concealment to the muscles.

Her mind is quick in its operations, arrives at earlier maturity, but is less vigorous, than in man. The passion of love, although indomitable, is more a sentiment with her than with the other sex. She seems, however, especially designed for the reproduction of the species, and for the early care of her offspring.

614. Sensibility, irritability, and therefore mobility, are more exquisite than in the male, and, for a like reason, she is more susceptible, as with the infant, and the sanguine and nervous temperaments,

to the action of morbific causes. Sympathy predominates, also, in the female; and hence local diseases are more apt, than in the other sex, to disturb other parts. But she is not, therefore, more liable to death; since the vital powers being more strongly pronounced, they are more recuperative, and the same susceptibility to morbific causes renders her, also, more susceptible of the genial effect of remedial agents. What Providence has denied to one, He has given to the other.

IV. CLIMATE.

615. The influences of climate, in modifying the physiological character of man, are great and various, and still greater and more various in predisposing him to disease. The physiological effects of climate are also strongly shown in animals, though often far less in their organic than their animal economy; while in the vegetable tribes these or analogous results are often strongly manifested in organic life (§ 604–606).

616. I shall speak now mostly of those permament effects of climate which are known under the denomination of temperaments, for the purpose of illustrating still farther the radical changes which may be established in the vital states by physical agencies (§ 585–603). This, also, will show how profoundly climate may operate in disposing the organic functions to a state of disease, and will contribute, with what has been said in other places, in inducting us into a knowledge of the philosophy which relates to predisposition to disease.

617. The extremes of heat and cold are conducive to the formation of the sanguine temperament, either in maintaining it as an inherited peculiarity, or in developing it out of other constitutions. But, it is mainly the dry heat of the tropics which goes to the formation of the sanguine temperament. The phlegmatic and sanguineo-phlegmatic belong mostly to warm climates, especially to such as are moist. The choleric and melanchólic occupy the temperate regions; and here, therefore, we may look for the demonstratious of genius. The choleric and melancholic gradually merge into the sanguine, or phlegmatic, in tropical regions.

618, *a*. The philosophy of life, as already expounded, enables us to comprehend the manner in which the foregoing transitions and varieties are brought about; while the changes confirm that philosophy (§ 617). Thus, when the melancholic migrates from the temperate to a tropical climate, the uninterrupted and powerful action of heat upon irritability and sensibility renders these properties more and more susceptible to the action of blood, and all vital stimuli. The secretions and excretions become, in consequence, more abundant; morbific and remedial agents manifest corresponding variations in effect; and since, also, the organic properties of the brain sustain the modifications incident to other organs, and the senses acquire greater liveliness, the whole character of the mental faculties takes on that of the sanguine temperament, and what was once an uninterrupted effulgence of mind, dwindles down to occasional scintillations. This is especially the course of the transplanted melancholic if the temperament incline to the sanguine. But here, as with the choleric, or where the sanguine and melancholic are distinctly associated, if the temperament lean to the phlegmatic, the vital properties are rather

depressed by heat, and the functions of the body and mind are more slowly and feebly performed; being influenced even by the vicissitudes of season, and by the daily atmospheric changes.

In the tropics, therefore, man is indolent, given to pleasure, and lives only for himself. With the natives of high northern latitudes, the properties of life are under the perpetual influence of cold, which fails, in consequence, of its usual action as a stimulus in temperate climes, and all the functions are slowly performed; save only the generation of heat, which has its special final cause. Growth must therefore be slow and stinted, and there must be (*cæteris paribus*) great capability of resisting morbific causes, and a gradual recovery from disease. The temperate climates, holding an intermediate rank in their vital relations, it must be here that we shall find mankind representing the most perfect attributes of their nature.

618, *b*. The same philosophy holds in respect to animals and plants, since all observation teaches that they are as sensibly affected, in certain aspects, by the diversities of climate, as the human race; being, also, like man, subject to modifications from education, soil, &c. (§ 605, *b*).

619. We thus see that climate contributes largely to the formation of temperament, and exerts direct modifying influences upon the general character of disease. In this last acceptation it embraces all the predisposing causes which appertain to different regions; such as the various kinds of miasmata, temperature in its general aspect and as liable to vicissitudes, moisture and dryness, and other obvious conditions. Physiological principles lie at the foundation of the whole.

620, *a*. From the considerations which have been now made, as well as for other reasons, chronic diseases should abound in the temperate zones, while they are comparatively rare in equatorial climates. Consumption is a grand characteristic of the former, especially of the sea-board and other humid regions.*

620, *b*. The principle about which the facts just stated are concerned, as well as others that are relative to climate, is well illustrated by the rapidity with which the chronic maladies of horses yield to tropical influences; a large proportion of these animals which are destined for the West India markets being thus affected, and thus relieved.

621, *a*. The remarks which have been now made in respect to climate lead me to indicate an important duty of the physician as it respects the inhabitants in an individual sense; though I have in view its philosophical as well as practical bearing.

* True, it has been lately stated on the authority of the British Army Statistics, that consumption is more rife on the West India stations than in any other quarter of the globe; from which the conclusion was drawn that the disease was especially incident to those climates. This important fallacy I have pointed out in the Medical and Physiological Commentaries (vol. ii., p. 619–622). In that work, also, especially in the Essays on Blood-letting, and on the writings of M. Louis, I have set forth the facts, which, with the preceding, and others of a coincident nature, enforce the importance of rejecting all army statistics, and other hospital reports, as forming any proper foundation for great pathological and therapeutical conclusions; and have endeavored to show that all such conclusions should be drawn exclusively from the private walks of the profession, where the constitution is natural, the habits good, and disease early and judiciously treated, and where, especially, the superintending physician is, bona fide, the prescriber and critical observer, and more anxious for the recovery of his patient than for a *post mortem* examination. Hospital reports represent nature in her most distorted aspects, the treatment of disease being often begun at its moribund stages, and when the system is full of organic lesions; this treatment, too, often experimental, and without reference to fundamental physiological principles (§ 623).

The native and the acclimated are apt to possess very different susceptibilities from the new-comer, from which it results that the treatment of their diseases, respectively, should be more or less governed by these considerations; while it will be, also, the important business of the physician to point out to the stranger the means of averting the new morbific influences to which he is subjected, and his modified susceptibilities. The means are various, and of the highest moment. It was from their neglect, as I have shown, that the mortality from consumption has been so great upon the West India stations, and the Report of which has led to so many theoretical and practical errors (§ 620, *note*). And as to the importance of a proper adaptation of treatment to the acute forms of disease upon the same military stations, it is only necessary to consider the appalling contrast between the results of practice as introduced by Robert Jackson, and that which immediately preceded his superintendence as surgeon-general. By diminishing, also, the allowance of "salt beef and rum" to the sick, he saved the British government $400,000 per annum. And who does not know that it is the same now as in Zimmerman's day? "I know," says Zimmerman, "a certain Esculapius who has fifty or sixty patients every morning in his antechamber. He just listens a moment to the complaints of each, and then arranges them in four divisions. To the first he prescribes bloodletting; to the second a purge; to the third a clyster; and to the fourth change of air! The same vulgar prejudice leads people to have a great idea of the practice of large hospitals. I have seen, in my travels, some of the largest hospitals in Europe; and I have often said to myself, Heaven, surely, will have pity on these miserable victims."

621, *b*. In connection with the foregoing should appear the modifications which arise from peculiarities in the specific nature of the remote causes of disease, which are almost as various as the causes themselves. We know, indeed, that the pathological cause of inflammation may be varied by the manner in which wounds are inflicted; and more various, therefore, must be the exact modifications which are determined by agents which possess specific properties. To know those modifications presupposes, in no small degree, a knowledge of their special causes. They demand a great versatility of treatment where common principles may apply; and this may be determined more by a knowledge of the remote causes than by any resulting phenomena (§ 644, &c.).

V. HABITS, OR USAGES.

622. It now remains to speak briefly of the last subdivision of our fifth grand division of Physiology. Under the denomination of Habits are included the various pursuits of mankind, their social and political relations and institutions, their modes of living in respect to food, exercise, clothing, &c.; with a special reference to their physiological and pathological influences, which are great and numerous.

Much of this subject is considered under the direct physiological aspect of vital habit (§ 535, &c.), and the same principles obtain throughout. The usages of man not only variously modify his vital condition in a transient manner, but, like the effects of climate, incompatible habits may establish permanent and transmissible changes of constitution. The glass-blower, the brazier, the painter, the type-

setter, &c., have, respectively, modifications of a common disease, which are still different from those of the sedentary divine, lawyer, and shoemaker. And so of the various pursuits which demand more or less exercise in the open air.

623. Habits, in their most extended sense, open upon us a field for endless observation. Here it is, in the neglect of the natural means of preserving health, in the pinches of poverty, in the filth of indolence, in Bacchanalian indulgences, and in the various resources of licentiousness, we meet with nature so turned from her physiological condition, that when disease sets in, it presents the most embarrassing anomalies. The hospitals of all countries, especially of Europe, show a disgusting amount of these artificial deformities. And yet are they sent forth as legitimate grounds for important conclusions in pathology and therapeutics (§ 620, *note*).

All the foregoing varieties of disease, which grow out of deleterious habits, or pursuits, may yield to the substitution of natural means, or to change of employment.

624. As to the active treatment of the cases last recited, I can only say, that, while the great principles obtain in less artificial states, they demand greater modifications of practice than all other special conditions that are incident to man. But, let us remember, that when we meet with phrenitis, or pneumonia, or any other grave inflammation, ay, or even erysipelas, affecting the most broken-down constitution of the most dissolute man, stimulants will be pernicious, and he must take his chance from a modified antiphlogistic plan.

625. Under the category of habits may be arranged the modifications which are exerted upon the constitution by subdued diseases. There are many affections which leave their subjects not only unusually susceptible of morbific agencies, but modify the pathological character of the diseases which may subsequently spring up. The dyspeptic affections that follow recoveries from fever are more obstinate, and require a more varied treatment, than such as arise from simple indolence, or even from high living. Syphilis, though cured, predisposes to an obstinate form of rheumatism, which requires a different detail of treatment from that which is induced by cold, or by hepatic and intestinal disease.

SIXTH DIVISION OF PHYSIOLOGY.

THE RELATION OF ORGANIC BEINGS TO EXTERNAL OBJECTS

626, *a*. That division of physiology which concerns the relations between living beings and external nature is very comprehensive, and brings into immediate connection the three great departments of medicine; and it is the object of these Institutes to consider the subject under this limited aspect. Here it is that these several branches meet together, and here it is that we learn that pathology and therapeutics are only modified aspects of physiology. They are all immediately interested about the properties of life; physiology regarding the healthy influences of external agents upon those properties, pathology their morbific effects, and therapeutics those changes which are exerted upon the morbid properties by remedial agents. A common principle is, therefore, concerned throughout. All the diversified results, whether physical, or vital, are directly dependent upon the existing condition of those properties. That condition is ascertained, in all its mutations, by the resulting phenomena.

626, *b*. Upon this ground, also, as upon that of the more internal economy, may be utterly exploded all the chemical and physical hypotheses of life and disease; since, were any of those doctrines founded in truth, the action of external causes should be directly upon the composition and structure. And so should the blood itself upon the sanguiferous system, urine upon the bladder, bile upon the intestine, &c.

The moment we begin the study of effects as manifested by living beings, whether induced by internal or external causes, or those which arise from the action of living beings upon outward objects, we find ourselves surrounded by an endless variety of phenomena which denote the existence of a formative principle, upon which all the impressions are made, and which is the primary cause of all that are made upon external bodies,—which moves the body from one place to another, exerts all the changes that are effected in food, elaborates that, and that only, from the universal mass which is suitable for the formation of blood, which governs all the processes of organization, which is susceptible of alterations in its condition in consequence of the action upon it of many external objects, which is liable to analogous influences, healthy and morbid, from the operations of the mind and its passions, and which possesses an inherent tendency to return from a morbid to its natural state, the essential cause of preservation. Surrender these doctrines, and all our reasoning about organic beings, all our physiological and medical philosophy, would be a mere jargon of words. Hence it may be always seen, that those philosophers who deny the existence of a principle of life, or substitute the chemical forces, are driven to the necessity of speaking and writing as if allowing its full operation, the moment they concern themselves about the phenomena of life. They must have, and they know it, a peculiar cause for effects so peculiar as those of organic beings.

627. In my examination of the constitution of the different tissues,

and of the properties and functions of life, the topics embraced within the present division of Physiology came, unavoidably, under analysis; and have been variously reproduced when investigating the laws of vital habit, the influences of age, temperament, climate, &c. But little, therefore, remains to be added.

628. In regarding our relations to external objects, we should carefully discriminate between irritability and sensibility, the two properties through which the relations are established; the former connecting organic life, the latter animal life, with the external world (§ 188, &c., 194, &c.). Vegetables, therefore, hold their connection through irritability alone; so that their organization is intimately associated with outward objects. The connecting anatomical structure in the organic life of animals consists of the alimentary canal, the lungs, and the skin; in plants, of the radicles and leaves (§ 268, &c.).

630, *a*. In organic life, as has been already seen, agents of all kinds operate through the medium of irritability (§ 188). Their effect depends upon the *degree*, and the *kind* of irritability, and upon the *kind*, *energy*, and *quantity* of the agents (§ 133, &c.). Owing to changes in the degree of irritability, the same stimulus or sedative, and in the same quantity, does not always produce the same amount of effect. It will be more, or less, on one day than on another, even at one hour than another. This is constantly exemplified in the natural states of the body, but distinctly in disease, when irritability is also modified in *kind* as well as in degree. The law is of great importance in medicine, and is subject to many contingent influences, both in health and disease, especially that of vital habit. These influences involve some of the most difficult and delicate considerations in the practice of medicine.

630, *b*. Again, the alterations of irritability in morbid states, whether in degree or kind, will depend upon the virtues of the morbific agent, and upon the natural modification of the vital properties in any particular part. This combined condition, and according to its nature, requires particular adaptations of remedies, whose operation, also, will be in conformity with their own virtues, and with the natural and acquired conditions of the organic properties (§ 150, &c.). The principle is, also, equally true of all diseases in their development of sympathetic affections.

630, *c*. From what has been said of the natural modifications of the vital properties in different parts, and of the specific relation of natural and remedial agents to those various conditions, it is obvious that the same morbific agent will affect one organ more or less differently from what it will another part (§ 133, &c.). Cantharides will not offend the stomach, but will excite inflammation of the bladder, and of no other part, in its proper therapeutical doses. And just so, though less remarkably, of the ordinary causes of disease. Cold and dampness constantly excite inflammation of the mucous coat of the nose, trachea, and lungs, while they far more rarely affect other parts. One poison strikes at the brain, another at the liver, and another at the skin, though their primary action may be often exerted upon the stomach. Other directions, however, may be given to each of these morbific causes when they are brought to act upon parts which are already diverted from their natural states, and will be liable to other variations from the numerous accidental influences by which every

individual is surrounded. It is these fluctuating influences which render measles, scarlet fever, the intermittent and yellow fevers, typhus, &c., more malignant at one time than at another, or more violent in one person than another. The same law obtains even in respect to idiosyncrasy, as in those subjects who are not affected by the poison of the rhus, &c. (§ 585, *b*). The differences result mainly from different modifications of irritability, and corresponding influences of various causes.

630, *d*. As all morbific agents differ in their *kind*, so are the effects of all more or less different from each other. Each one, or according to their combined influences, other circumstances being equal, affects the organic states in one uniform way; and this is as true of the malaria which generate typhus and yellow fever, the plague, &c., as of the virus of small-pox, measles, hydrophobia, &c. The differences in results will, of course, be most strongly pronounced when the morbific causes differ most from each other.

SEVENTH DIVISION OF PHYSIOLOGY.

DEATH.

631. Organic beings die; nothing else. What is it, then, that dies; and why, in consequence, do living beings return to the mineral kingdom? The functions, it is answered by many philosophers. But the functions are merely results. It is their causes, then, that perish. And what are the causes? The chemical philosophers answer, the forces which are capable of so many results in the inorganic world,—the chemical forces. But the facts contradict that philosophy; for no sooner is the organic being dead, than we witness an exactly opposite series of results as the effects of chemical changes. We witness, I say, a demonstration of chemical results beyond any other example in the natural world, and it is then only that we witness them at all. The causes which are withdrawn must have been as peculiar as the universal phenomena that have disappeared, and as opposite to those chemical forces which take possession as their power of resisting them during life is unimpregnable. These causes have been called the vital properties, which, like the powers or properties of the mind, are elements of one principle, which is known by the name of the vital principle. It is the extinction of this substantive principle which essentially constitutes death, as its existence essentially constitutes life. Those who deny its existence are generally, also, materialists in respect to the soul, if they be not chargeable with a greater vice.

632, *a*. The tendency to death, in man at least, having been introduced since his creation, the properties of life must have undergone some miraculous change. Man was created imperishable. By sin came death, and by perseverance in sin, a farther abbreviation of life. We must admit this doctrine of Holy Writ, and apply it philosophically. We may not reason as to the Order of Providence, had the material man been immortal. Doubtless, ample "room" would have been provided for his indefinite multiplication, at least in the ultimate abode of the translated Prophet.

632, *b*. But, assuming that life has been shortened from a thousand years to "three-score and ten" by the agency of physical causes, there must have been a miraculous change in the condition of the inorganic world, since it has been without change, in its relations to disease, up to the earliest records; but the very face of the earth assures us that there has been neither a natural nor a supernatural change in the condition of matter, or in the laws of inorganic nature. We are therefore compelled to take the Revelation of Heaven as it stands; or, in denying one part, to deny, also, the longevity of primeval man; which will obliterate all common ground between the disputants.

633. Life does not generally reach what may be called its natural termination. We have already seen that its natural extinction is the work of its own progressive movements; that it is the result of the same creative operations that developed the ovum into the new-born offspring,—that continued the same process through the various stages of life up to the time of full maturity,—that still went on with the

work of superaddition, till at last, by the progressive condensation of organs, by clogging the sanguiferous system with interstitial deposits of bony matter, &c., it loses its control over its own instruments of action, and fails for want of means to carry on its productive operations. It is not, therefore, from any natural failure of the properties of life, or any "wearing out of the machinery," as is commonly supposed, that life ultimately becomes extinct, but from the prolongation of that process by which it laid the substratum for those active operations, which, when once begun, must be continued in uninterrupted progress along with the original creative function (§ 63–82, 123, 170 *c*, 175 *b*, 176, 237, 584). This ultimate effect, as well, also, as the exposure of life to the influence of morbific causes, is a striking exemplification of the Order of Providence in carrying out His final purposes in the natural world, where the general plan has been miraculously diverted from its original design (§ 632, *b*).

634. The principal elements in the production of death may be found in the modes by which it may be suddenly effected. 1st. By the failure of the circulation, as in syncope. 2d. By the failure of respiration. 3d. By sudden and pernicious determinations of the nervous power upon the circulatory and other important organs. 4th. By the same determination of the nervous power upon the organic properties of the brain, as seen in instant death from apoplexy, anger, joy, surgical operations, blows on the stomach, &c., though, in these cases, there is also a pernicious nervous influence propagated to the heart, &c. (§ 230, 510, 511). Death from syncope is immediately owing to the failure of the heart to supply other parts with blood; though the nervous power is especially instrumental in prostrating the organs of circulation (§ 940–942, 947–949). Death from abolition of the respiratory function is owing especially to a consequent failure of the decarbonization of the blood. It is remarkable how speedily a loss of consciousness, and, of course, of all sensation, is sustained by the suspension of this function; and it may be of interest to some to know the facts as lately experienced in my own person. Being precipitated into a stream of water by the upsetting of a stage (my head through the window of the carriage), and perfectly conscious when first beneath the water, the reflections which occupied my mind could not have continued one minute. There remains the most distinct recollection of that brief period. The subsequent details, till consciousness was restored, may not be without an interest. My momentary efforts at extrication were defeated by the weight of the passengers, and I continued to occupy the foregoing position till nine of them, and mostly females, could be lifted through the uppermost door, and while the carriage, heavily laden with baggage, could be rolled over. This process consumed at least some seven or eight minutes, and three or four more had elapsed after my extrication before signs of reanimation began to take place. A large assemblage of farmers from the neighboring fields were standing around, when the first moment of consciousness was announced by a noise as of distant speakers, and a simultaneous view of the spectators. Vision was at once perfect; but the sounds advanced progressively nearer and nearer, and within a quarter of a minute had identified themselves with their proper sources; when, also, consciousness was completely re-established. It may be also worth saying, that only a very slight uneasiness attended the suffocation.

635. Nothing extinguishes life more immediately than a destruction of all the functions of the brain, whether by a direct injury of the organ, or by an abolition of the circulation. The effect is nearly as great when interrupting the respiratory process by dividing the medulla oblongata. But in this case the influences are different from such as obtain in diseases of the brain, or in injuries done to that organ. If sufficient to embarrass or to suspend respiration, the nervous power is determined with a pernicious effect upon all the organic viscera; but very variously, according to the nature of the injury or of the disease (§ 478–482, 510, 634, 948). A simple removal of the brain and spinal cord occasions death, not only by suspending respiration, but by interrupting their influence upon the great organs of life; which must be also true within greater limits of the division below the medulla oblongata. In the former case, as we have seen, no pernicious influence of the nervous power is determined upon the organic viscera; in the latter, a direct violence being inflicted upon the spinal cord, a destructive effect is propagated upon the organic properties, which reaches to the brain itself (§ 129, 455, 456, 476½ *h*, 478, 479, 489, 507).

636. Death from disease generally depends upon complicated causes, and upon profound affections of more organs than one. In a general sense, also, the particular mode of death will depend upon the organs diseased, upon the violence and kind of affection, and upon the particular condition of other parts.

637. It is rare that absolute death takes place at once in all parts. Evidences of this are seen in the peristaltic movements, in the contraction of the voluntary muscles, in the discharge of the arterial blood into the venous system, in the occasional exaltation of heat, &c., after apparent death (§ 447, *d*). We have seen, also, how remarkably the heart may be roused into action long after its pulsations have ceased (§ 262, 498 *e*, 516 *d*, no. 7), continuing, in some animals, to pulsate with a "rustling noise for ten hours after being hung up to dry" (*Med. and Physiolog. Comm.*, vol. i., p. 17). In other instances, the heart has been "often seen to raise a weight of twenty pounds," soon after apparent death; and Lord Bacon states that he has seen the heart of a criminal, when the organ was thrown into a fire, leap to the height of seven feet, and to continue these movements, with a gradual decrease, for the space of seven or eight minutes (§ 384; also, *Comment.*, vol. ii., p. 401, 402, &c.). In my work on the *Cholera Asphyxia of New York*, 1832, I have spoken of contractions of the voluntary muscles which continued in progress, drawing up the legs, &c., for an hour and a half after apparent death (p. 141). These contractions took place without the application of any exciting cause, and it may be difficult to say whether, as in the case of the extirpated heart and intestine, they were alone due to the independent exercise of mobility in its connection with irritability, or whether the nervous power operated as a stimulus, through a preternatural development which may be incident to the radical change in the organic constitution, analogous to that development which is attendant on syncope, and which in this case, besides its powerful demonstration upon organic actions, often induces spasm of the voluntary muscles (§ 948). The analogies in this respect, and such as are represented in section 500, are strongly in favor of the latter construction, while the inde-

pendent action of the extirpated heart and intestine may seem to favor the other. But the analysis of sympathy which I have made in preceding sections (500, &c.) shows a special difference in the motive constitution of the organic viscera and of the voluntary muscles, and in the relative agency of the nervous power as it respects their motions. In the former case this power is mostly a regulator of independent organic actions; in the latter it is an indispensable stimulus (§ 188, 205, 215, 222, &c., 261, 500, 526 *d*).

If the foregoing construction be true, then the muscular contractions which follow, after apparent death, from blows upon the limbs, are equally due to the development and action of the nervous power (§ 516 *d*, nos. 8, 9); and the whole conclusion is farther strengthened by the involuntary movements of decapitated animals, and by the muscular contractions which are effected by the stimulus of galvanism, both in life and apparent death, and especially when consequent on pricking the skin after removal of the head. The latter case, indeed, is exactly analogous to motions produced in the limbs of the human subject by mechanical violence; since in the case of the decapitated animal there is no direct irritation of the muscles, and, therefore, no possible mode of propagating the impression upon the skin to the muscles, excepting through the nervous power. All this, too, shows us that, whatever differences may exist between the vital constitution of man and animals, and among animals, they are essentially constituted alike, subject to the same fundamental laws, and having only modifications ingrafted upon them.

It may be thought that all this is a useless refinement in philosophy. But such is not my opinion; nor have I any doubt that better minds will carry out these suggestions to more important developments in the philosophy of life. Even in death itself much may be gained that will be useful in physiology; and if we follow the organic being till he is resolved into elementary substances, we shall gather something at every stage of the process that will contribute light to organic science, and yield an interest to the study of putrefaction (§ 54 *a*, 56, 62 *e*).

SUMMARY CONCLUSION OF PHYSIOLOGY.

638. From what has been hitherto said, it appears that medicine, in all its branches, is a perfect whole, bound together by intimate relations and dependences, nowhere contradictory, but all in unison, and irresistibly flowing from one great system of Unity of Design, which is the grand characteristic. The foundation is laid in the *Principle of Life, and its various attributes.* The demonstrations of that principle, and of those attributes, begin with the elements of organic beings, their number, the modes in which they are united, &c.; and the sameness of the principle throughout, and the coincidences in its laws, are attested by every fact in physiology and medical philosophy.

By recurring to the demonstrations already set forth, it will be seen that my fundamental ground is clearly established; for, whether it be the elements of organic beings which are combined in peculiar numbers, proportions, and modes, and forever in one peculiar and exact manner in every distinct part of every organic being, and which are maintained in combination against the adversities of disease, and against those chemical agencies which may produce their almost instant dissolution when the vital chain is severed; and whether we consider, also, the remarkable nature of those elements, and that in the animal kingdom, especially, nitrogen gas abounds in the various tissues, notwithstanding the entire kingdom is far more liable, than the vegetable, to chemical decomposition after death; or, whether we pause at the threshold of life, and consider all the unvarying facts attendant on the development of the ovum, how one part after another springs into existence in a never-deviating, foreordained manner, and as each part may be necessary to the next succeeding, how the same exact process of formation, and no other, is continued till the being becomes again a subject for the mineral kingdom; how the semen, also, is a type of all the various subsequent agents of life; how we may here detect the nascent causes of transmitted disease, operating in conformity with those which play their part in the external world; how mind itself is impressed upon the embryo, and how the intellectual peculiarities of either parent may be ingrafted upon the offspring, as are their physical traits, their temperament, their constitution, their very manners,—where, I say, all is uniformity in the grand movement of organization, and nothing but coincidences in the fluctuations that may arise from preternatural causes, and always the same according to the precise nature of those causes; or, if we follow the immature being to its state of maturity, and observe that the progress of development is always the same, under equal circumstances, at every stage of its progress, whether in the animal or the plant, and notice, also, the coincidences which obtain between the two organic kingdoms, as in the changes of tissues, in the variations of products, up to the consummation of the whole in that perfect state which is characterized by the development of the generative organs, the flower, the ovum, the seed, and the mutual office of sexual intercourse; or, whether it be a corresponding exact organization and vital endowment of every part of every organic being, yet different in every organ, and often so in different parts of one and the same continuous tissue as it traverses

different parts of the compound organism; or, whether we regard the products of each organ, or of each tissue, or of the several parts of a continuous tissue, respectively, and observe that they are forever the same in the same animal or plant, under equal circumstances, yet different in every part, and more or less different from each other in every species, whatever the similitude, or consider that the same products are forever modified in health and in disease in one exact manner, under any given modifying influences, whether natural, morbific, or remedial; or, whether we interrogate the nature of the relations by which external or internal causes divert the phenomena from their natural states, and observe that the results depend upon the exact original and acquired nature of the part and the nature of the influences, and that they are in perfect harmony with such as emanate from the natural stimuli of life; or, whether we consider how the manifestations of disease denote, like those which emanate from the natural stimuli of life, an established difference in the closely-allied constitution of the same or different tissues, and different parts of a continuous tissue, as in the inflammatory affections of various parts of the mucous, or the serous tissues, and the more remarkable peculiarities attending the inflammations of the lining membrane of the veins,—prostrating the circulation and giving to fever its malignancy; or, whether it be a small current of air impinging upon the neck, which will suddenly induce an attack of catarrh, or of pneumonia, or of rheumatism, when no such effect may follow an equal exposure of any other part of the surface, or even of the entire skin for an equal time; or whether, in a remedial aspect, leeches, or a warm bath applied to the feet, may restore menstruation when the same applications to other parts might be insufficient, or other analogous phenomena which abound in the history of morbific and remedial agents; or, if we consider the philosophy which concerns the first act of inspiration as generated by the contact of air with the surface of the body, and that it is exactly the same as that which is relative to the first inspiration in syncope when cold water or cold air are applied to the face, or stimulants to the Schneiderian membrane, and even the same when the mucous tissue of the lungs becomes the point of departure,—the same, too, which concerns all those modifications of respiration which are known as coughing, laughing, crying, sneezing, hiccough,—the same as obtains when light, impinging upon the retina, produces either a contraction of the iris or a paroxysm of sneezing,—the same as when a leaf of tobacco applied to the sole of the foot may disturb every function of the body,—the same when cathartics, or emetics, or alteratives, &c., may send their influences abroad through the medium of the gastro-intestinal mucous membrane,—the same when shame mounts to the face, or fear expels the blood from the surface, or covers it with moisture, or stimulates both kidneys and bladder, or as anger convulses the heart and braces up the animal muscles,—the same, in principle, whether one or the other be applied in a physiological, pathological, or therapeutical sense; or, whether we regard the organism as a whole, and consider how all parts concur in harmony together; how numerous parts are supplied by natural stimuli, consisting of blood or of products from it, which conspire together in maintaining the good of the whole, but either of which would be offensive to other parts, and disturb the harmony of the whole; or how the nervous

power sheds its regulating influence upon all parts of the animal mechanism, and how, through that same power, from its natural susceptibility to the existing healthy state of every organ, both external and internal causes may lay the foundation of disease, or effect its removal, or occasion the most violent commotions, or extinguish life in a moment; or, whether we consider that the same relative facts prevail in respect to the vital signs that distinguish the physical products, and that they go hand in hand together, under the same established or contingent influences, natural, morbific, or remedial; or, whether we scrutinize the coincidences between the facts that are relative to the changes that happen at the different eras of life, and to gestation, lactation, &c., and such as are brought about by morbific and remedial agents, and consider that the latter are a necessary consequence of the natural mutability of the fundamental constitution from which the former emanate; and that those which are natural are an exact type of the influences and their mode of production when morbific or remedial agents operate upon distant parts by impressions exerted upon the stomach or skin, or when disease of one organ gives rise to disease in another; or, whether we regard the corresponding facts which are relative to vital habit, or those which result from the influences of climate, &c., and which bestow the radical modifications that form the peculiarities of temperament, &c., and see, also, that all these variations are produced by causes that operate through the same fundamental constitution; or, whether our hygienic and therapeutical treatment may be greatly regulated by each of the foregoing conditions, whether natural or acquired; or, whether it be the peculiarities of idiosyncrasy that render certain ordinary articles of food morbific to certain individuals, or the analogous constitution of marine and terrestrial plants which demands for the former the briny waters of the ocean, while they are fatal to the latter; or, whether, in like way, the mere approach within ten feet of the poison rhus will produce a violent erysipelatous imflammation over the whole surface of one person, when even the handling the plant will never affect another; or, whether the rolling of a few blue pills with the fingers will establish salivation, and affect the adult constitution of some, while a pound of calomel taken by the stomach will not affect others in a similar manner, and rarely at the early stages of life; or, whether it be bloodletting, or the mercurial or the antimonial alteratives, that are often baffled by the precise modifications of the specific forms of active inflammation, while they readily subdue the common form and many specific chronic inflammations, and whose differences in results denote the modifying influences of the remote causes of closely analogous affections; or, whether mercurial agents be strictly morbific in their action upon the salivary glands, while they are simultaneously and powerfully curative of hepatic and other diseases; or, whether a mercurial cathartic will induce salivation if the susceptibility of the system be increased by the associate use of other cathartics or by loss of blood, when, *per se*, no such effect may be produced; or, whether the same effect follow the mitigation of fever, when no extent of the remedy may reach the constitution in high grades of febrile action; or, whether the bite of the mad dog will produce hydrophobia in all mammalia, while the disease cannot be imparted by any other than the canine and feline tribes; or, whether the poison of the rat-

tle-snake, or of the wourari tree, or numerous other poisons which are certainly and rapidly fatal when inserted beneath the skin, be perfectly innoxious when taken into the stomach or applied to the surface of the brain; or, whether it be the virus of the small-pox, of measles, &c., that effects certain modifications of the vital states relative to each particular agent, and to no other, that forever protect the system, in a general sense, against a second attack; or, whether it be the cow alone, as with other animals in respect to the virus of hydrophobia, that can so modify the variolous poison as to generate in man the equally protective vaccine disease; or, whether the susceptibility sometimes remain so as to give rise to another modification, while the varioloid, in its mildest state, but not the vaccine, will generate, by contagion, in the unprotected, the most virulent form of the original disease; or, whether it be the analogous miasmata that only slowly extinguish the susceptibility to their morbific effects after repeated attacks of the particular forms of fever which they are, respectively, capable of producing, or, if the subject thus acclimated remove to another region, his original susceptibility may return,—being analogous, also, to those physical agencies which establish the temperaments, and which change from one to another as the old influences may cease, and new ones operate, while analogies, in these respects, are also supplied by the variolous and vaccine diseases; or, whether it be bloodletting, or an emetic, or a cathartic, that produce their alterative effects with a rapidity proportioned to the rapidity in which their sensible operation goes on; or, whether it be the alterative in small doses, and in its abstract sense, that slowly establishes analogous changes in the morbid states; or, whether an alterative, as antimony, for example, must be generally increased in its successive doses to keep up the effect of the first dose, or, if there be, in respect to antimony, a suspension of the remedy for at least twelve hours, we must then go back to the original smaller quantity to avoid an excessive effect; or, whether, on the other hand, other alteratives, like mercury, or foxglove, or cantharides, or arsenic, or quinine, or ipecacuanha, will manifest no sign of their influence for several successive doses, but will, at last, without any increase of the dose, suddenly display the full effect of their virtues; or, whether by associating ipecacuanha with the sulphate of zinc, the latter will so exalt the susceptibility of the stomach that the two agents, otherwise unequal in time, will simultaneously co-operate in their emetic effects; or whether, in the same way, a diffusible stimulant, associated with a permanent tonic, will quicken greatly the action of the latter; or whether, in like manner, and like the virus of small-pox, of measles, &c., or like the miasmata, it be opium, or hyoscyamus, or digitalis, or mercury, &c., that reduce or increase the susceptibility of the stomach and of the general system in relation to the virtues of each agent, respectively, but to those of no other; or, whether we consider other examples of vital habit, and observe how pungent stimuli cease to annoy the nose, the mouth, the stomach, &c., but only so in relation to each of the agents, respectively, or how tobacco, which is morbific in most diseases, and originally offensive to all, finally becomes the most universal luxury of man; or whether we consider the manner in which the alteratives, in their small and oft-repeated doses, maintain their influence, and extend their silent

invasions upon disease, or how emetics, or cathartics, continue to propagate their curative effects after their complete expulsion from the body, and see that the principle is disclosed by the natural phenomenon of the permanent contraction of the sphincter muscles, which, although the urine or the contents of the rectum be evacuated, are maintained in equal contraction by the irritation which remains upon the mucous tissue, and through which the nervous power is uninterruptedly determined upon the sphincter muscles ; or whether we regard the coincidence between respiration, spasmodic affections, and the voluntary movements of the respiratory, or of other muscles, and observe that each is alike due to the propagation of the nervous power upon those muscles ; or whether we contemplate the same vital agent in its production or removal of disease, and in its absolute mode of operation, and see that the changes which are thus effected consist in some alteration of the natural or morbid states, and according to the nature of the remote cause, whether it be positive, like mercury, or negative, like cold, or immaterial, like the mind and its passions, and according, also, to the special exercise of one mental power or another, or the operation of one passion or another, and thus proving the susceptibility of the nervous power to various modifications that coincide with the virtues of the remote cause, and a coincidence, in this respect, with the changes which are perpetually exhibited in the organic vital conditions, and which are even brought about by the nervous power itself; or, whether we realize the foundation of these last phenomena in the naturally exquisite susceptibility of the nervous power to various influences, that it may constantly operate as a regulator of the rhythmic movements of all parts, and through a law of the nervous system by which all parts are exquisitely sensitive to the condition of each other, and through which all remote morbific and remedial influences are exerted ; or whether, in like way, inflammations are varied in their character by contused, and punctured, and incised wounds, or more greatly so by all animal and vegetable poisons, whether morbid or natural, and mostly so according to the special nature of the remote causes, respectively, or, if subordinate influences diversify the effects of many principal causes, there be others which control all other influences, as in small-pox, measles, scarlatina, &c. ; or whether in fever, as in inflammation, there be analogous varieties, corresponding, in like manner, with the special virtues of each cause, while the fundamental pathology is of one common nature in all the varieties of inflammation, and of another common nature in all fevers ; or whether an ephemera be the type of the intermittent, the remittent, and continued fevers, and of their several modifications, and consider how the paroxysms of the intermittent commonly observe established intervals of twenty-four, forty-eight, and seventy-two hours, or, if the usual time be anticipated or delayed, the paroxysms are then apt to go on with the particular irregularity with which they began, or when, by regular anticipations of the period of each last preceding paroxysm they approach the night, one paroxysm is often lost; or whether we look at the effects of all our best and most universally remedial agents, as bloodletting, mercury, antimonials, cathartics, &c., and see that they are strictly morbific to the healthy system, in their remedial doses, and that, therefore, they are at least equally so in their action upon diseased organs, yet contributing to their cure; and while, also, we

know that neither such nor other agents can, of themselves, transmute the morbid organic changes to those conditions which are natural to the being, we yet discern the reasons of their favorable effects in the spontaneous and successful efforts of unaided nature, and in those speedy recoveries from morbid states that are induced in the healthy system by remedial agents, in their remedial doses, and thus infer that remedies only contribute to the cure of all diseases by instituting morbid changes that are more conducive to the naturally recuperative process; or, whether the cure of intermittents be effected by bark, or arsenic, or cobweb, or opium, or an emetic, or bloodletting, or abstinence, or by an emotion of the mind, &c.; or whether it be stimulants or sedatives, bark or bloodletting, conjointly or separately, that may subdue many inflammations, acute or chronic, and thus, also, prove the near identity of the pathological state in all the varieties, and that nature recognizes no such opposite conditions as *active* and *passive* inflammation; or whether it be the abrupt removal of pertussis by an hour's exposure to the open air where all other means had failed, or the improvement of an ulcerated limb by the same temporary influence; or whether ice, or ipecacuanha, or common salt, or opium, or bloodletting, or the sulphates of zinc, and of copper, or catechu, or kino, &c., will alike arrest capillary hemorrhage or redundant secretions, by modifying the action of the capillary vessels; or whether loss of blood, and tartarized antimony, or a dash of cold water upon the surface of the body, or even a warm bath, be far better "*refrigerants*" than pounds of ice, or of lemonade, taken into the stomach; or whether, among the "*sudorifics*," the drinking of hot water, of mint-teas, &c., will excite a more immediate and more profuse perspiration than tartarized antimony, or ipecacuanha, &c., and the former exert no other apparent effect, while the latter may be profoundly curative or morbific, or bloodletting surpass the whole in all these respects; or whether it be the "sialogogue," like horse-radish, which only exerts an effect on the salivary glands through a continuous irritation along the salivary ducts, or mercury, which induces salivation only by constitutional influences; or, whether we turn our attention to other corresponding laws, and to other analogous coincidences, and consider, for example, how all but chyme is prevented from passing the pyloric orifice, how all but the air is excluded from the lungs, how all but chyle from the lacteals, how all but white blood from the serous vessels of the arterial system, notwithstanding the far greater diameters of some than those of the red globules, and yet that when the irritability of one is morbidly affected, as in indigestion, solid food will pass out of the stomach; or of another, as when certain morbid impressions are made upon the lacteals, the deleterious agents may obtain a sparing admission; or of another, as in inflammation, the red globules are allowed to pass freely in; or, if we glance at those more astonishing phenomena which attend the generation of animal heat, and observe that all non-hibernating mammalia maintain one uniform temperature, under all circumstances of food, clothing, &c., whether at the poles or at the equator, yet each species, respectively, possessing a temperature of its own, and that the very giant of the mammiferous tribe, in the midst of everlasting icebergs, obeys this law of uniform and exalted heat,—exalted not less than four degrees above that of man; or turn our admiring contemplation to the few exceptions that occur in the hi-

bernating group, and see how that temperature, which is equally uniform under all torrid and temperate degrees of the circumambient air, sinks down as the thermometer descends from 40° F. till the animal scale reaches nearly the freezing point, and then rises, with a bound, to its original exalted standard, while the mercury goes on to the point of zero; or, if we drop from this gradation in analogy, to the cold-blooded race, and observe how they obey the physical law of an interchange of caloric with the surrounding medium, yet within the limitation of a specific and independent power of maintaining a counteracting influence that preserves them at a few degrees of heat above the lowest of the external medium which may be endured,—eating, digesting, and performing, too, the same organic functions as the mammalia; or, if we consider, also, the same peculiarities in the living egg, and their absence where its incubating property is extinct; or, if we turn ourselves to the vicissitudes of temperature which attend the phenomena of disease, and remark how they correspond with all the admitted vital changes,—rising, in one case, to a degree of intensity where there is almost a total privation of food, and an extensive destruction of the lungs, or sinking, in another, to an almost icy coldness, where the subject is plethoric and the stomach is crowded with food and alcoholic stimulants; or whether, also, we regard the same principle in its natural state, as seen in the process attending the reproduction of the stag's horn, or in that of lactation, and consider that here is the fundamental element implanted in the constitution for great and wise purposes, and that every other consideration points us directly to the natural constitution itself for an interpretation of every phenomenon in the history of animal temperature, and deduces a coincidence between these phenomenon and those of the organic processes, under every aspect of stability, individuality, and of change; or whether it be a thousand other different, but analogous considerations, relative to the influences of foreign, natural, morbific, or remedial agents upon man or other organic beings; or whether we again look to the mind and its passions, and see the long exercise of judgment impairing digestion, while imagination comes in as a speedy restorative; or whether it be anger or joy, like a blow on the stomach, or like the shock of a surgical operation, that strike us dead in a moment, or grief that does but slowly undermine, or hope that throws its balmy influence over every disease, by whatever cause produced;—whether, I say, it be one or the other of the considerations now mentioned, or thousands of thousands of similar import, which crowd the history of living objects, each and all are in harmony with each other, and concur together in one universal demonstration of the peculiar constitution of animated beings as distinguished from the inorganic kingdom, and declare their essential dependence upon one principle, namely, a VITAL PRINCIPLE, *of various elements or properties*, whose definite character in their natural conditions, and whose instability or liability to permanent and temporary modifications and changes, and whose disposition to return from such as are only temporary to their original state, lie at the foundation of all the phenomena, will explain every phenomenon, and whose unity as a whole is supported by every phenomenon of organic beings. This consideration, therefore, assures us that we have already compassed the general philosophy of life, of disease, and of medicine; and we contemplate with admiration the sim-

plicity, yet complexity, of the principles, the stupendous whole, as it swells from the comparatively simple phenomena of the development of the ovum, when the properties of life are exposed to no influences that shall affect their instable nature, till we have traversed the animal kingdom in all its exposures to those influences, and have witnessed the incalculable variety of change which the organic properties and functions sustain in consequence of those exposures, and observe that the whole immense system, all the variety, springs from the simple influences of external and internal causes upon the properties of life, and that slight changes in those properties, like the differences which prevail among the results of their natural modifications in different animals, and in different parts of a common or a continuous tissue, give rise to all the differences between health, disease, and convalescence; —in the contemplation of all these things, I say, we are employed in witnessing the most comprehensive and sublime system of UNITY OF DESIGN, and enjoy the conviction that we are cultivating a science whose foundations are laid in the most CONSUMMATE WISDOM (§ 892).

PATHOLOGY.

639, *a*. Having now laid a broad foundation for the superstructure of pathology and therapeutics, in the exposition of the properties, the functions, and the laws of organic beings in their natural states, and in contrasting the philosophy of the more difficult problems with those interpretations which have been borrowed from the phenomena of the inorganic world, that nothing may obstruct our way, and that whatever is true in any of the conflicting views may shine with greater lustre, I am thus prepared to go on with those lofty objects about which the healing art is immediately interested. I say, to go on; for in all my physiological inquiries, I have endeavored to indicate the relations of the ultimate branches of medicine, and to approach these branches already prepared with a connected view of their dependence upon natural institutions. The complexities in physiology give rise to corresponding intricacies in pathology and therapeutics, and it has been therefore necessary to explore the ground-work in such various methods, and with such variety of illustration, as shall impart to pathology and therapeutics a consistency in principles, a ready interpretation of their endless problems, and give to the hand of art enlightened confidence and firmness in the right. I have designed that this right shall follow naturally and easily from the premises hitherto laid down, and if I have come short of that, then have I failed in fundamental requisites. No system in physiology can stand which is not true to Nature in her altered aspects; none that does not come to her interpretation under all the varied conditions and phenomena of disease; none whose elements conflict with each other (§ 516 *d*, no. 6, 524 *a*, 524 *d*). There must be clearness, individuality, harmony, demonstration. I claim not that I have accomplished all this. I do but say that I have attempted it, and with an earnest hope that the effort may not prove abortive. As much has been said, and much remains, which is original with myself, and generally relative to the most profound and important topics, and, as there has existed the necessity of exhibiting in a satisfactory manner those conflicting errors which have obtained such general ascendency, I have been impelled to all the amplitude of inquiry which may obtain either the acquiescence of the profession in the doctrines which I have taught, or their ready rejection.

639, *b*. Pathology concerns the changes which the vital properties and functions undergo in disease, and the resulting changes in the vital and physical signs, and finally reaches to those lesions of organization that fall within the purview of morbid anatomy (§ 695, &c.).

Pathology consists essentially, therefore, of those modified states of the physiological conditions which constitute disease.

640. Such, also, are the relations between the natural physiological conditions and those diversions which make up disease, that the latter often reflect the most important light upon the natural ones. The properties of life, in all their aspects, as well as their corresponding

functions, are not unfrequently best comprehended through the phenomena which distinguish their various departures from the normal standard (§ 198, 303$\frac{2}{3}$).

641. Pathology is divided into general and special. The first considers diseases in common; the second treats of the particular history of diseases. A distinction has been also made into medical and surgical pathology; but it is unfounded in nature, though it may be convenient in practice.

642, *a*. As all diseases have their remote causes, and often reflect much light upon pathological conditions, these should be embraced in the department of pathology.

642, *b*. The vital properties are so susceptible in their nature, that the good, as well as the evils of life, is constantly inflicting disease. Whatever is salubrious in due proportions becomes morbific in excess. The mildest nutriment in excessive quantities, or at unseasonable times,—an unrestrained indulgence of the passions,—inordinate exercise, &c., prove the instability of the vital powers. We are also surrounded by agents of noxious virtues, some of which we may avoid, but covet as luxuries,—while others, if we would avoid, are beyond our control (§ 150, 152).

643. We are therefore led to consider pathology under three principal heads; namely,

I. Remote Causes of Disease.
II. Proximate or Pathological Causes.
III. Symptoms.

I. REMOTE CAUSES.

644. The remote causes of disease are the first in the series. By their deleterious action on the properties of life, they give rise to those changes which constitute the proximate or pathological causes, or the essential conditions of disease (§ 188–192).

645, *a*. Remote causes are subdivided into *predisposing* and *exciting* or *occasional* causes.

645, *b*. The *predisposing* causes are the most important; being indispensable to all idiopathic fevers, and to all specific forms of disease.

645, *c*. The *exciting or occasional causes* are such as develop an attack of disease after the predisposing have laid the foundation. The latter, therefore, may produce their full impression, and the subject escape an attack, unless afterward exposed to the exciting causes. The predisposing, however, often operate with such intensity as to prove exciting, also; as in small-pox, measles, hydrophobia, poisons, injuries, malaria, &c. (§ 559). But the mildness, or intensity, of many of these affections, as in the contagious diseases, may depend upon the antecedent operation of other modifying causes; whether of a predisposing or protective nature.

Again, the exciting cause often consists of something which, under ordinary circumstances, may be perfectly inoffensive; such as a full meal, a few glasses of wine, privation of sleep, anxiety, grief. In such cases, there has always been an antecedent predisposing cause in operation; but either of the foregoing may operate both as predisposing and exciting causes.

646, *a*. Remote causes are either *internal* or *external*.

646, *b*. The *internal* consist, for example, of the passions, laborious

study, retention of the fæces, hereditary predispositions, &c. (§ 75–80, 144, 561).

646, *c*. The *external* consist, 1st. Of such as are ordinarily salutary, but become morbific by their excessive or too frequent use, or when used at undue seasons, or when the body is disqualified for their use. 2d. Such agents as injure mechanically the structure of our bodies. 3d. The great class of truly morbific agents, which embraces a large variety in the several departments of nature, comprehending, even, a large proportion of the *materia medica*, when exceeding the therapeutical doses, or when employed in these doses under circumstances of health.

647. Among the most important of the internal remote causes of disease are morbid conditions already formed. They may be either exciting or predisposing, or operate as conjoint causes. In the former case, other causes have brought about the predisposition. They are the great fountain of sympathetic developments; and, as one springs up after another, each in its turn, and all together, contribute toward new complications and the difficulties and danger of the case (§ 117, 129, 227, 501).

648, *a*. The predisposing causes are *general* and *specific*.

648, *b*. The *general* are such as may be in simultaneous operation upon many individuals, and are, then, mostly connected with the atmosphere, giving rise to influenza, and other catarrhal affections, &c. Of these there are commonly several in combined operation; though there is generally one more important than the rest, especially in acute forms of disease.

They consist, also, of all those causes which give rise to the various forms of *common* inflammation, and all other conditions of disease which do not fall under the next subdivision.

648, *c*. The *specific* causes form a far more numerous class than the general. They consist of all the natural or healthy and morbid poisons, animal and vegetable, and the principal agents of the materia medica. Each of these will generally establish the predisposition by itself alone, and is generally the exciting as well as the predisposing cause. Among these causes must be ranked all those which generate idiopathic fever; and these being of vegetable origin, must float in the atmosphere, and around the multitude. They are, therefore, the main causes of epidemics, properly so called (§ 650, 663). Such causes are generally aided in the development of disease by others which are simply exciting (§ 654, *a*).

648, *d*. The predisposing causes of sporadic diseases are apt to be more numerous than those of epidemics.

649, *a*. Remote external causes do not produce their effects indiscriminately on all parts to which they are applied. Some are perfectly inert upon the skin, while others exert their principal effects upon this organ. And so of other parts. The surfaces upon which they operate are, 1st. The mucous tissue; 2d. The skin; 3d. The surface of wounds and abraded parts; 4th. By being forced into the vessels when wounds are made by instruments charged with poisons. It is in the last two ways alone that many of the most active poisons produce their effects; such as the hydrophobia virus, the poison of serpents, the wourari poison, &c.

649, *b*. Some parts of a continuous mucous tissue are more suscep-

tible than other parts of the same tissue (§ 133–137). And so of the skin. A current of cold air, for example, striking the neck, more readily produces catarrh than when impinging on any other part; while its direct action upon the healthy mucous tissue of the lungs is never deleterious (§ 136). Menstruation is most readily suppressed by cold applied to the feet, &c.

The foregoing facts depend upon a principle of vast importance, in every branch of medicine. Thus, in relation to the pulmonary intestinal mucous membrane, we learn from it, physiologically, that the generation of gastric juice, and the elaboration of carbon from the blood, are conducted by a special vital process, &c. (§ 135, 419), and this, with various other relative facts, such as the variety in effects of natural stimuli, goes to illustrate what is denoted, by morbid phenomena, of the special susceptibilities of different parts of a continuous tissue to the action of morbific causes, and how the same disease presents important varieties in the several parts; and, carrying these important considerations to therapeutics, we readily come to a distinct apprehension of the reason of the differences, local and constitutional, which spring from the action of the same remedy upon one part or another of that same tissue; as, for example, why tartarized antimony may relieve croup by its action upon the stomach, but may kill in the same case by an equal effect upon the intestine. And now, casting a glance at the universal body, we see the same law prevailing in other tissues, and among all parts which differ in organization. These combined circumstances open an immense field of philosophical and practical inquiry, and should forever employ the physician in a critical study of the therapeutical relations of the various articles of the materia medica to one part or another, in their local and sympathetic effects, and according to the precise pathological conditions of all the parts which are likely to feel the influence of the remedy, or as it may affect the more natural conditions of other parts, and, therefore, their favorable or unfavorable reflected sympathies (§ 129–152, 500 *n*, 514 *h*).

649, *c*. There are probably but few ordinary morbific agents which affect the skin in its sound state, though some may which are not suspected. Cold is one of the most remarkable. There are but a few of the active poisons of the materia medica that either affect this organ sensibly, or other organs sympathetically through it. Mercury, tartarized antimony, and cantharides, are among the strongest examples of the action of remedial agents upon the skin, and through that organ upon remote parts. But, while blue pill, and the blue mercurial ointment, whose active principle is insoluble, produce inflammation of the salivary glands, and affect the system at large, after their application to the skin, they exert no more manifest effect upon the skin itself than when a cold current of air gives rise to pneumonia or rheumatism (§ 655). And since the insoluble preparations of mercury are no more absorbed than the cold air, it is evident that their direct action, like that of cold, must be exerted through the cuticle upon the organic properties of the skin.

Cantharides and tartarized antimony, on the contrary, affect the skin sensibly, and in a direct manner, and other parts, as in the foregoing case, by sympathy. But, tartarized antimony applied to the skin will not induce nausea, nor affect the constitution at large, whatever its

morbid susceptibilities, but only certain parts in the vicinity of its application, and then only when those parts are preternaturally susceptible (§ 143). It then operates, like blisters, through contiguous sympathy (§ 497).

When, however, almost any article of the materia medica is taken into the stomach, it produces an obvious impression upon that organ, or upon the intestines. Sympathetic influences are then transmitted to other parts; and it is upon this great law in relation to the intestinal canal especially, that the curative effects of remedies depend. A strong analogy is also thus supplied in proof of the primary action of many of the profoundly morbific agents upon the alimentary mucous tissue; since the positive remedial agents are as truly, though more transiently, morbific (§ 901). It may be one part or another of that tissue,—where it traverses the nose, or the mouth, or intestines, according to the special virtues of the operating cause, and the natural or acquired modifications of the vital states in either part (§ 150, 649 *b*), just as one moral emotion or another will, respectively, and habitually, strike at this part or at that of the foregoing tissue, or again descend upon other parts of the organ as it may fluctuate in its vital states; or, at other times, may aim at other organs (§ 227, 500). The mucous texture of the lungs is, also, doubtless, often the seat of morbific influences from external agents; though here we have no great range of analogies.

649, *d*. The reason why the skin is so little susceptible of the influence of morbific and remedial agents consists partly in the protection which is afforded by the cuticle; not, however, because of the supposed impervious nature which is inculcated by the mechanical philosophy, but that the cuticle is a mere shield to the very susceptible properties of the true skin. When, therefore, that guard is removed, numerous agents operate with great and rapid effect, and send their influences abroad with great power over the system. Hence, one of the obvious final causes of the cuticle.

650. Every distinct morbific agent (and every remedy), however allied to others, has its peculiar virtues, which produce, *cæteris paribus*, a general corresponding modification of the vital properties and functions (§ 52). If two or more be united, chemically or mechanically, the compound is an agent of new virtues, and produces corresponding effects (§ 188½, *d*). This is the reason for combining remedial agents. Hence arise many varieties of inflammation, and of idiopathic fever; the differences being greater where the morbific causes differ most from each other, or, as two or more may operate (§ 766). This is rendered distinctly obvious by the specific character of those diseases which follow the application of morbid or healthy animal poisons in each of the cases, respectively. Thus, the poisons of small-pox, of measles, of scarlet fever, &c., always affect the vital condition in nearly one uniform way. From these distinct and strongly-marked affections we might safely reason to all other morbific agents; but, independently of this analogy, which rarely fails in relation to any organic laws, we have the same proof, though less remarkable, in respect to other affections. In the great family of idiopathic fevers, among which there are close resemblances, there is no rational doubt that each variety depends upon specifically different predisposing causes. It appears, also, to be well ascertained that these causes are of vege-

table origin, and that the differences in their nature depend upon different combinations of their elementary principles, that take place during the decomposition of vegetable matter. This difference in decomposition, and the consequent generation of each peculiar poison, according to the new and exact modes in which the elements recombine, is owing to various chemical influences; such as peculiar states of the atmosphere as to heat, moisture, light, &c.; and also upon the kind of vegetable matter, its simplicity or variety, the nature of the soil, whether wet or dry, whether impregnated with fresh or salt water, or whether the vegetable matter be superficial or mixed with earth, &c. Certain climates, cities, &c., will generate varieties of fever, and of other diseases, which never happen in other places.

All the foregoing has its exact analogies in the natural agents of life (§ 136).

651, *a.* The predisposing causes, nevertheless, give to disease no small part of its special character, while in each tissue, or part of a tissue, of any given organ, the exact pathology also depends on the special vital constitution of that part (§ 132–152).

651, *b.* Age, sex, habits, &c., exert, also, certain influences upon the results of the remote causes of disease; and it is owing to analogous changes in the vital states that the usual effects of any morbific cause in ordinary constitutions may be variously modified in constitutions which possess natural or acquired peculiarities, &c. The influences left by former diseases, and whatever may have diverted the properties of life from their perfectly natural character, or have increased their susceptibility, will be conducive to the deleterious action of morbific causes, and of many of the ordinary stimuli of life, and may variously modify the results in the several cases, respectively. Hence there is scarcely a limit to the modifications of disease, while they may agree in the general outlines (§ 153–156, 163, 535–630).

652, *a.* By no circumstances, however, is the pathology of disease so greatly determined as by the predisposing causes; and this important result, therefore, will be more or less affected by the simplicity or the variety, and intensity, of the causes, as well as by their nature (§ 722).

652, *b.* But, there is not only one predisposing cause which is generally most important, and which mostly rules the pathology, but there are many morbific agents which are capable of so controlling all other influences as to determine certain uniform morbid conditions, whose symptoms may be foretold; particularly the healthy and morbid animal poisons. The contribution, however, which is often made by other causes as to the intensity and complications of exact diseases is well manifested in epidemic scarlatina, epidemic measles, and epidemic dysentery (§ 663).

652, *c.* The precise vital influences of any remote cause, their dependence upon the exact nature of that cause (all other things being equal), is critically displayed by the effects of slightly varied mechanical agents. Thus, "a mere prick or scratch is usually followed by cutaneous erysipelas; but not so with a deeper wound; and a punctured wound is less likely to induce it than a lacerated one" (§ 722, 725. Also, *Med. and Phys. Comm.*, vol. i., p. 610; vol. ii., p. 474–480). And so in the same critical sense of the acclimated subject when a new epidemic influence may prevail, as set forth in section 551.

More striking distinctions, and according to the nature of the cause, are shown by such agents as opium, cantharides, mercury, the virus of snakes, of the mad dog, of small-pox, measles, scarlatina, &c.

The importance of enforcing this fact, in a *practical sense* at least, is shown by a common disregard of the subject, as occurs in the following example. Thus,—Pereira, in his erudite work on the Materia Medica, very justly says, that, "the *precise* pathological condition of the brain and spinal cord of an animal under the influence of hydrocyanic acid is matter of conjecture." But he adds,—"Whatever it may be, it is probably *identical* with that which occurs during an epileptic paroxysm, and with that induced by loss of blood." Now, loss of blood will often remove an epileptic paroxysm, at once; and is the best remedy for the cerebral congestion induced by hydrocyanic acid, after its depressing effect is over.

652, *d*. The physiological inquirer will not fail to apply the foregoing facts in opposition to the chemical and physical hypotheses of life and disease.

653, *a*. Animal or vegetable poisons, if natural or healthy, are the product of natural organic actions; if morbid, they are generated by diseased actions; if altered from the foregoing conditions, they are more or less the product of chemical decomposition.

653, *b*. Since, also, every *specific* disease requires its exact cause, and as every cause of disease which is elaborated by the living organism requires a certain precise state of the organic properties and functions for its production, or if more or less of a chemical nature, it has lost its original peculiarities, it follows that the disease which is produced by a healthy animal or vegetable poison cannot be generated by a morbid one, and *vice versa*, nor can a chemical product become the cause of a disease which is induced by poisons that are exclusively the product of organic action, as in small-pox, measles, yellow and typhus fevers, &c. And since small-pox is produced by a morbid organic product, and can never, therefore, arise from another cause, and can be alone propagated by contagion, so, also, as the foregoing fevers depend, in certain known instances, upon the products of vegetable decay, they can never be of a communicable nature. Nevertheless, other causes may predispose the body to the operation of the more specific predisposing agents, so that small-pox, measles, &c., may be unusually epidemic and malignant.

653, *c*. Healthy animal poisons, therefore, are never generated by the diseased processes which they excite; but the morbid ones are reproduced by such processes, and by no other, and mostly by individuals of the same species, while the same law of individuality is universal as to healthy animal poisons.

653, *d*. For the foregoing reasons, no contagious disease can ever be propagated by any other cause than such as is generated by that precise modification of the vital states which constitutes the essence of the disease. By the same inductive process, all those affections which have for their causes the products of laws which govern inorganic matter can neither be regarded as contagious by the philosopher, nor shown to be so by the man who doubts every thing but his senses. The laws of life and the laws of chemistry are as wide as the poles from each other. No organic action can form the chemical combinations of dead matter, nor can the forces of chemistry imitate the mor-

bid any more than the healthy products of life (§ 43, 44, 52, 53, 150, 191 *a*).

Since, therefore, miasmata produce yellow fever, plague, typhus, &c., it clearly follows that the living system, when affected by those diseases, cannot generate a poison capable of producing the same affection in others, since the poison depended originally upon vegetable decomposition (§ 657 *b*, 741 *b*).

But, independently of this incontrovertible law which is predicated of numerous facts in physiology and pathology, and without one to invalidate its force, the whole of this question as to the contagiousness of fevers is settled negatively by a great variety of direct observations. (See *Objections to the supposed Contagiousness of Yellow Fever*, &c., in *Med. and Phys. Comm.*, vol. i., p. 445–453, *note*, 532–534; vol. ii., p. 511.)

654, *a*. Specific predisposing causes, consisting of animal, and mineral, and most of the vegetable poisons, generally produce their sensible effects with great rapidity. Even vegetable miasmata, in a state of concentration, may determine an attack of idiopathic fever as soon as their operation begins (§ 648). It is upon this rapidity of effect that much of the utility of the materia medica depends (§ 554). I have accumulated examples of this nature in the Medical and Physiological Commentaries (vol. i., p. 471–474, &c.). But as no small number believe, with Louis, that "it is not true, as has been said too often, that *facts* do not become old, and the *immense majority* of them have become so; and, moreover, those which we collect in *these times*, will, in like manner, in their turn, become old" (the "numerical method" to the contrary notwithstanding, *ibid.*, vol. ii., p. 810), I shall, I say, in view of this skepticism in respect to "facts" (§ 5¼, *a*, *e*), present an instance fresh from Bombay (1846) relative to the malignant cholera, and as yielding "food for the mind contemplative." Thus, the writer:

"Who shall depict the scene in the hospitals? I speak more of the Fusiliers, because of that I saw much; every cot was filled—delirium here, death there—the fearful shrieks of pain and anguish. Men whom you had seen a short time before hale and strong, were rolling in at every door, crowding every space—countenances so full of misery—eyes sunken and glaring, shriveled and blackened cheeks. This, too, the work of five short minutes or less! So sudden was death with some, that they were seized, cramped, collapsed, dead, almost as fast as I have written the words. Previous health and strength were no guaranties; men attending the burials of their comrades were attacked, borne to the hospital, and buried themselves the next morning. Pits were dug in the church-yard morning and evening; sewed up in their beddings, coffinless, they were laid side by side, one service read over all."

The foregoing paragraph, as well as the facts to which I have just referred, in another work, may remind the reader of what has been said of the action of hydrocyanic acid, nux vomica, &c., and lead him to appreciate the analogies in the modes in which morbific and remedial agents bring about their results, and strengthen his philosophy of the properties and laws of organic beings (§ 494 *dd*, 827 *d*).

654, *b*. The foregoing, however, is not equally true of morbid animal poisons, which are alike specific. I may also say, as farther il-

lustrative of great vital laws, that morbid animal poisons have, commonly, the remarkable attribute of producing their sensible effects at more determinate periods than any other predisposing causes, with a few exceptions like the hydrophobic virus. It is also another striking fact, that natural small-pox occurs in about fourteen days after exposure, but that the intermediate period is only eight days where the same disease is communicated by inoculation. The disease, too, is violent in the former, and comparatively mild in the latter case; thus showing that slight variations in the condition of the predisposing causes will not only vary the duration of the predisposition, but modify all the phenomena of the ensuing disease (§ 650, 651). This is more particularly seen in the relative history of natural small-pox and the cow-pox, which are, essentially, one disease. It is an example, also, which illustrates the specific modifications of the properties of life in different animals; since we know of no other than the cow (certainly not the human species) that can so alter the variolous poison (§ 545. Also, *Med. and Phys. Comm.*, vol. ii., p. 184, 195–200).

654, *c*. Again, there may be an interval of weeks, months, and years, after the application and the removal of the predisposing cause, before disease ensues. This is witnessed particularly in some remarkable exceptions which occur among the specific causes; as those which generate intermittent fever, while the same causes may also develop an attack with great rapidity (§ 654, *a*). "When a cause is applied which produces fever," says the philosophical Fordyce, "it produces it *uno ictu*, although the cause be no longer applied. Neither is it increased, diminished, or altered, by the farther application of its cause."

654, *d*. Where the sensible effects follow rapidly the application of the causes, the predisposing is generally adequate to the full production of disease; and it may be equally so where the interval is longer, as in small-pox, hydrophobia, &c., though more commonly some exciting causes are necessary, as probably in a large proportion of idiopathic fevers. Hence, an attack of these diseases may be often prevented by a proper regimen.

655. Specific causes commonly operate with greater certainty than the general (§ 646); and this is owing, in part, to the circumstance, that the former generally act both as predisposing and exciting causes. But, even the effects of these may be moderated by a proper regimen. Low diet, for instance, after exposure to small-pox, measles, scarlatina, &c., or after inoculation, or exposure to the causes of fever, will lessen the severity of the disease. The principle is the same as when a stimulant diet, &c., contribute to their production (§ 551).

656. The ordinary exciting causes, which, in their usual force, commonly fail of producing disease where a morbid tendency has not been induced by predisposing causes, may readily become predisposing, or both together, by a greater intensity of action.

657, *a*. It commonly happens, especially in acute diseases, that, when predisposing causes are not followed immediately by a development of disease, the principal morbid states take place in organs distant from that on which the morbific causes exert their direct action. The main predisposition, therefore, is produced by sympathy in the remote parts; and of course it is there that the principal explosion of disease takes place. It is subsequent to this, that the surfaces

on which the agents exert their direct action become sensibly involved in disease; and then it is probably quite as much a result of sympathetic reaction from the organs where the main explosion takes place (§ 148, 514 *h*, 524 *c*, 743). This is especially true of the alimentary and pulmonary mucous tissue, and of the skin, upon the former of which malaria appear to exert their direct action. The principle is seen distinctly in the pulmonic inflammation, rheumatism, &c., which follow the action of cold upon the skin, and in the application of mercurial ointment, and other unirritating remedial agents, to the undenuded surface (§ 649, *c*). And so of other remedies addressed to the stomach. They commonly exert their most sensible effects upon the remote parts now rendered particularly susceptible by the presence of disease (§ 136, *d*). But examples of remedial influences more in point occur in subsequent sections (§ 902 *m*, 905). In respect to morbific causes, however, there may not exist any preternatural susceptibility of the distant parts, but the agents establish their effects in conformity with laws already indicated (§ 150, &c.). The propagation of their influences in the foregoing manner is replete with problems of the deepest interest in medicine, and reason is often conducted to the truth by a firm hold upon a long chain of analogies. In this way, for example, we arrive at a knowledge that hydrophobia follows the law of propagation by nervous influence. The hydrophobic virus establishes certain imperceptible morbid influences upon the bitten part, which are sympathetically propagated over the system; and here, as in miasmatic fever, the predisposition is sufficiently formed in various other parts as not to require, for the general explosion, a full development of disease in the bitten part. There are commonly present, however, in hydrophobia, symptoms which denote either inflammation or morbid irritation of the injured part, just antecedently to the general explosion, which is precipitated by it. Hence, also, the reason why the removal of the bitten part, many days, or even weeks, after the infliction of the wound, may prevent hydrophobia; which it would be absurd to explain by the humoral philosophy of this disease (*Medical and Physiological Commentaries*, vol. i., p. 499–505).

657, *b*. It will have been seen that a peculiarity attends idiopathic fever in its universal invasion of the body (§ 148, 757, &c.); and this leads me to indicate a certain difference in the sympathetic propagation of the predisposing influences from what may obtain in the more circumscribed forms of disease. In the operation of the predisposing causes of fever, the impression which is propagated from the direct seat of morbific action gives rise to coincident pathological states throughout the system, where there is no interference from inflammation or venous congestion; while other morbific causes are apt to result in various modes of disease, as the effects of sympathetic influences radiated from their seat of action. In the former case, therefore, the general extension of sympathetic impressions is equivalent, in principle, to a specific universal action of the original predisposing cause (§ 228, 653).

658. If disease be limited to the part on which the morbific cause makes its direct impression, the changes may be then instituted by the direct action of the cause upon the organic properties, and without any necessary intervention of the nervous power. And so of remedial agents, as when caustic is applied to ulcers, vesicants to the skin, &c. But,

it more commonly happens that the reflected nervous power is the immediate agent in the production or cause of disease, though seated in the part to which the morbific or remedial agent is applied. This reflection of the nervous power may come either directly through the nerves supplying the part, or from organs more remote (§ 184, 188, 205–216, 222–233¾, 475, 476–492, 500, 514 *b*, 657).

659, *a*. Predisposing causes are often involved in much obscurity, especially when of a complex nature. Their operation may have begun at some remote period, and there may have been a long consecutive series without much relation to each other. Neither may be sufficient to lay the foundation of disease; but each renders the properties of life more and more susceptible to morbific influences from other causes, but which, otherwise, might have been innoxious These new causes being applied, one after another, alter more and more the natural condition of the vital properties and functions, till, at last, some new, and perhaps as mild a cause, produces a sudden explosion of disease. This last cause is often mistaken, and often fatally for the patient, as the principal, or only source of a malady, which has been the slow consequence of a long series of causes. And so of the last remedy, after a series of remedial influences.

Thus it frequently happens that the first in the chain of predisposing causes begins in childhood, and the last does not take place till adult age. The gastric and hepatic inflammations, which supervene on the indigestion of adult life, have often grown out of improper food in childhood, and a neglect of other natural habits, which are continued till habitual indigestion sets in. It then becomes difficult, from the influence of habit, to accomplish a cure; and these patients, too often indisposed to exercise self-denial, go on with persevering indulgence, and carry forward the morbid changes, till obstinate and even disorganizing inflammations ensue (§ 548). Such, too, is the frequent history of intemperate drinkers, excessive tobacco chewers and smokers, opium eaters, &c.; the poison being slowly morbific in all the cases, but aided in its operation by many concurring causes (§ 543, 544, 562).

From this combined series of causes, and their gradual influences upon the vital conditions, there is every variety and gradation, as to number, time, activity, &c., down to those which, like a scald, or the bite of a venomous snake, develop inflammation at once, or, like prussic acid, extinguish on the instant, and without any other antecedent change, the entire powers of the organic being.

659, *b*. The foregoing gradual operation of morbific agents lays the foundation of the scrofulous diathesis (§ 836), and is analogous, in principle, to the philosophy of acclimation, and to the formation of artificial temperaments (§ 558, 560–563, 591). The causes, indeed, being perhaps not remarkably different, and only morbific under special circumstances, may transform the melancholic into the sanguineo-melancholic, or into the nervous temperament, instead of producing chronic indigestion, or some habit of feeble health (§ 535–540, 602).

660. In the last section we have examples of what is in constant progress in disease, namely, the predisposing influence which a diseased organ exerts on others which were not diseased. These sympathetic influences, leading to various sympathetic diseases, then fall within the category of predisposing causes; as do also the resulting

diseases; but, if they concur only in a secondary manner with other causes, then they may be only exciting, or both exciting and predisposing causes (§ 143 *b*, 222–232, 514 *h*, 647, 715).

661. Finally, all those hereditary peculiarities, in which there is a natural tendency in the vital states to take on diseased conditions, may be included under remote predisposing causes. But this is rather for the sake of convenience, since, in the hereditary constitutions, the tendency to disease is virtually no more than the common predisposition to disease, and is equally owing to remote causes which have exerted their predisposing effects upon our ancestors. It is convenient, therefore, to assume these transmitted peculiarities as equivalent to the remote causes themselves. And, although we cannot trace out the remote influences which lay the foundation of the scrofulous constitution, or of other hereditary predispositions, the known characteristic peculiarities of the accidental constitutions is equivalent to a knowledge of the nature of the remote predisposing causes; since in other affections we do but employ our knowledge of the predisposing causes in finding out the exact pathological character of disease. And so, also, of the several temperaments (§ 561, 585, &c.).

662, *a*. A knowledge of the remote causes of diease is often indispensable to the successful treatment of disease. Catarrh, for instance, arising from cold, in a sound constitution, although prolonged, may be suffered to pass without much remedial care; but, if it have for one of its remote causes a natural tendency to scrofula, or phthisis, it should awaken all our vigilance for its removal. The reason is obvious. In the ordinary catarrh, all the remote causes soon cease their operation, exert no profound nor specific changes, and the vital states soon obey their natural tendency to the standard of health. In the other case, remote causes had been in prolonged operation, are more or less of a specific character, and the resulting predisposition has almost the fixedness of the temperaments (§ 543, 548, 561, 562, 585, &c.). In these cases, therefore, the tendency of nature is to go the wrong way; and in proportion to this she requires the intervention of art. We must then make repeated impressions upon the diseased conditions, before we can establish the artifical changes, before we may counteract the naturally morbific tendency. This being accomplished, a favorable inclination is given to the balance of nature, and she comes in with languid efforts at restoration.

662, *b*. Again, a fever, or inflammation, with partial remissions, presents itself. The fate of the patient may now depend upon our knowledge of whether the principal remote cause consisted of marsh miasmata, or of some other morbific agent, although it have long ceased to operate; since, in the former case, the Peruvian bark, arsenic, &c., may be indispénsable, while in the latter they would be destructive (§ 870). It often happens, also, where the remote cause is still in operation, that its removal alone, especially those of a *general* nature, may be all that is necessary to a speedy cure (§ 648, 815).

Venous congestions, as will be seen hereafter, may be also attendant on intermittent fever, which shall ultimately require the Peruvian febrifuge, but which would be aggravated in most other cases. After bloodletting, it is the great remedy for the intermitting apoplexies of Italy, &c. In all these cases, the congestive affection is peculiarly modified by the nature of the predisposing cause (§ 816, 817).

662, *c*. Again, it has been always found, on dissection, that *delirium a potu* was attended with venous congestion of the brain; and such is the modifying influence of the remote cause, that one of its principal remedies is opium, and in quantities that would induce another modification of the same disease if administered in healthy states of the system, and for which bloodletting and coffee would be the remedies. This peculiar fact impresses us forcibly as to the wonderful modifications which different morbific agents establish in particular forms of disease, and enforces the importance of ascertaining the nature of the predisposing cause. Striking examples occur in the self-limited diseases (§ 859, 861).

663. The remote causes which readily produce disease in one man may not in another. Thus, during the prevalence of an epidemic fever, or the malignant cholera, or influenza, a greater portion of the inhabitants may escape the disease. There is, therefore, something appertaining to that part of the multitude which escapes, that enables them to resist the morbific effects of the prevailing remote cause (§ 648, *b*). And here observation, as well as vital philosophy, enables us to understand the reasons.

We find, for instance, in respect to yellow fever, and all other congestive fevers, prevailing epidemically, that their subjects are apt to live on, after the appearance of the distemper, without much regard to their habits. They eat as freely as usual of animal food, drink their wine, and perhaps more ardent spirits. Others have become infirm from irregular habits, and such are, in consequence, rendered more susceptible of the epidemical influence (§ 827 *c*, *e*).

On the contrary, we observe that the class who escape are more generally abstemious, eat less stimulating food, or renounce it altogether, abandon all alcoholic liquors, avoid the night air, retire early to rest, &c. (§ 615, &c., 623–625, 645 *b*).

And so, where there exist constitutional or other tendencies to disease; its attack may be averted by habitually avoiding many agents which are inoffensive to others (§ 150). Peculiarities in respect to temperament are, also, often concerned in the degrees of susceptibility to the influence of morbific agents; just as they are in respect to remedial. The sanguine, for example, will be more the subjects than the melancholic or the phlegmatic; and the former require greater vigilance as to exciting causes (§ 551, 597, 598).

664. Certain predisposing causes sometimes extinguish the susceptibility to their morbific action even in concentrated degrees, when they have been long in operation in degrees less intense; as in acclimation, the use of tobacco, &c. (§ 544, 545, 551). Some other causes always, or nearly so, destroy the susceptibility to their action through all future time, after having once produced disease. These consist, mostly, of a few morbid animal poisons; namely, of small-pox, measles, scarlatina, hooping-cough, and mumps. It is remarkable, too, that all these diseases are contagious without contact, and are the only ones to which this combined law applies (§ 545, 652).

665. Predisposition often remains after disease shall have been apparently eradicated; as seen particularly in intermittent fever, and in chronic indigestion (§ 515 *g*, 560). This persistence of predisposition is most likely to occur where some organic derangement may have supervened, or where a low chronic state of disease may estab-

lish itself in some comparatively circumscribed part, and which not only contributes to maintain the general predisposition, but afterward increasing, becomes one of the exciting causes of another attack of fever (§ 806). These local conditions are generally owing to imperfect treatment; to the neglect, perhaps, in intermittent and remittent fevers, of proper depletion, or to the use of excessive doses of quinia, &c. Acquired predisposition to particular diseases, however, often appears to be almost as firmly ingrafted upon the constitution as those of an hereditary nature, with intervals of apparent absence of all disease (§ 535, &c.).

666, *a*. Predisposition to disease consists in some indefinite change which has befallen the organic properties, and corresponds, in a general sense, with the peculiar virtues of the predisposing causes (§ 650, 652). Where the subsequent development of disease is severe, and especially if sudden, there has been, obviously, some profound antecedent impression upon the properties of life. Close observation, indeed, will generally detect, especially in predispositions to fever, many obscure symptoms which denote a change in the organic properties and functions, some time before the sudden and full explosion of disease.

A morbific impression being once made on the changeable properties of life, it may go on increasing in intensity, although the remote cause have been early withdrawn, till, having acquired a certain degree of force, disease may either explode spontaneously, or some mild exciting cause may institute a sudden and violent change in the now highly-susceptible properties of life (§ 514 *g*, 516 *c*, 516 *d*, no. 6, 518 *b*, 561, 574 *a*). At other times the predisposition appears to be stationary, perhaps for months, and even for years, as seen in fevers and hydrophobia; the former having been known to exist in a dormant state for a year or more, and the latter for seven years. In these cases, it appears ultimately to assume, of itself, a tendency toward a full development (§ 148, 514 *g*, 559, 561, 715, 826 *g*).

666, *b*. A distinct apprehension of the nature of acquired predisposition to disease may be had by referring to the philosophy of artificial temperaments (§ 591, 602, 603), and to those naturally modified states of the vital properties which so frequently result in hereditary diseases; as in scrofula, gout, bronchocele, &c. In some of those natural conditions which predispose us to specific modes of disease (§ 661), there is no apparent departure from a state of health, unless disease be developed by exciting causes (§ 578, *c*); and this will be true in proportion as the predisposition is limited to a few parts, and especially if those few be not important to organic life. Thus, the predisposition to gout is greatly limited to the small joints, though it may affect other parts, especially the intestinal mucous membrane. So, in bronchocele, the predisposition resides in the thyroid gland. In such constitutions, therefore, there is not generally any thing present, under ordinary circumstances of health, to denote any modification of the properties of life which approximates a condition of obvious disease. These cases are so far closely allied to those conditions in which the predisposition to fever, or to hydrophobia, is in a state of incubation for many months, or for years.

But, in scrofulous subjects, it is generally otherwise; since in those who are naturally predisposed to scrofula, the tendency to the disease

is more or less universal, and may affect almost every tissue and organ. There is, therefore, a natural radical fault in all the organic endowments of the system, and this fault or natural modification constitutes the predisposition (§ 661). Hence, in such subjects, the very elements of the body are diverted more or less from their perfect standard, and the union of their compounds into tissues and organs deviates, more or less, from that of natural subjects (§ 220). Irritability, especially, is not only permanently turned from its natural character, but is at all times preternaturally susceptible; and hence it happens that occasional causes, innocent in health, operate now with morbific effect (§ 143–150). These cases approximate those acquired predispositions where incubation is of short duration, ana where there can be no doubt that the organic properties sustain a profound lesion during the early operation of the predisposing cause, or take on, at an early time, a progressive tendency toward an explosion of disease (§ 76, 181, 578 *c*).

II. PROXIMATE, OR PATHOLOGICAL CAUSE.

667. The *proximate* cause, as implied by the term, is that from which all the direct phenomena of disease arise. It must therefore constitute the essence of disease itself; and hence I substituted in the Medical and Physiological Commentaries the term *pathological* for proximate, and have since retained it as more expressive than the original name.

668. The remote causes, by their action upon the properties of life, lead to that change in their condition which forms the essential pathological cause, or the essence of disease (§ 644, 658, 666). As a necessary result, there also follows a corresponding change in the functions over which the properties preside, and therefore a more or less modified action of the vessels which are the instruments of disease (§ 247). All the symptoms, altered secretions, lesions of structure, &c., are only consequences, more or less remote, of those primary changes.

669. Since, also, it appears that all remote causes which differ in their virtues, or in their modes of influence, establish changes in the properties and functions of life corresponding, in a general sense, with the nature of the causes, and with the modes and intensity of their operation, it follows that the pathological causes, or results of the predisposing, must vary in a corresponding manner (§ 650, 651).

670. But there are many remote causes that are so nearly allied in their morbific virtues, that they must produce pathological conditions of near resemblance. Such are the various remote causes of inflammation, and that other class which gives rise to idiopathic fevers. Since, however, many of the causes belonging to each class have certain very peculiar virtues of their own, there must necessarily arise corresponding peculiarities in the pathological conditions which they produce. Hence the very obvious differences which prevail among inflammations and fevers; though more or less is due to the nature of the affected parts, and often to many contingent influences. Inflammation of the venous tissue, for example, presents a combination of phenomena that distinguish it at once from inflammation of any other tissue, though the remote causes be the same. Much of the variety in congestive fevers is also due to a more inflammatory

state of one or more organs; while, also, venous inflammation is variously modified, as in all other tissues, according to the nature of the remote causes (§ 132–140, 149–152, 652, 722, 765, 766. Also, *Med. and Phys. Comm.*, vol. ii., p. 427–514).

671. Summarily, then, the precise nature of the pathological cause will depend upon the nature and action of the remote cause, or their combined nature when two or more operate efficiently, and upon the natural or other antecedent modifications of the vital properties of the affected parts, and the general nature and vital relations of any compound organ of which an affected tissue may form a component part; subject, however, to modifications from temperament, age, habits, &c.

672. Every disease consists of a succession of pathological causes, till they end in health, or in death. These changes are the result of the natural mutability of the properties of life, especially when once diverted from their healthy standard. The morbid states are rarely stationary from one hour to another. They fluctuate, favorably, from the inherent tendency of the properties to return to their natural condition, or from artificial impressions from remedial agents; or, unfavorably, from the intensity of disease, the force of predisposition and of habit, or from the continued operation of predisposing or exciting causes, &c. (§ 177–184, 535, &c., 666, 733 *e*). The progressive changes may be gradual, and require but slight modifications of treatment, or great and abrupt; and either condition may follow the same morbific and remedial agents, according to the surrounding influences.

The absolute condition of disease, therefore, is changing not only spontaneously during its progress or decline, but is variously modified by remedial agents, and by other contingent causes (§ 733, *d*).

673. It is to the actual condition of disease, and the organs involved, that remedies should be directed. A knowledge, indeed, of the seat of disease, and of its exact pathology as far as may be attained, is often indispensable to a successful treatment; and here a knowledge of the remote causes may contribute the greatest light (§ 650).

So, also, at every successive application of remedial agents, the new pathological conditions should form the ground of the new prescriptions.

674, *a*. Upon the modified conditions of the properties of life, or their pathological states, therefore, all the modified actions of the vessels which are the instruments of disease, all the vital phenomena, and all the physical products depend; just as the healthy actions, phenomena, and products depend upon the same properties in their state of health (§ 177, 410). It is for this reason, the modification of the vital properties in disease, or the essence of disease itself, is called the proximate or pathological cause; all the rest being merely results or effects.

But, there are only certain facts that may be understood in relation to the changes which the organic conditions sustain from the operation of morbific causes. We can see distinctly that they are exalted in inflammation, and exalted or depressed in fevers. But these are comparatively unimportant elements of the changes. There is also the greater change which consists in some absolute modification of the *nature* of the properties, some positive change in *kind* (§ 177, 666). What that change is it is impossible to comprehend, though it

be the essential part of the disease. We know not, indeed, the absolute nature of the vital properties in their healthy state, and have, therefore, no standard of comparison in disease. We may, nevertheless, by the phenomena, as of all other forces of nature, learn all the laws of the vital properties, and the modifications to which they are liable (§ 234). The physiologist, I again say, concerns himself about the facts, the anatomical medium, the existence of the forces and the laws which they obey. He interrogates not the intrinsic nature of the powers, nor the proximate modes in which the results are produced.

674, *b*. For the purpose of having some visible or tangible condition before us, in considering the pathology of disease, we often include some of the results as elements of the proximate cause, or even substitute some of the results for the cause itself. Thus, increased action of the capillary blood-vessels is often said to be the proximate or pathological cause of inflammation, though this is only a consequence, however a necessary one, of a certain morbid alteration of the vital properties of the vessels concerned in the morbid process. So, the pathological cause of venous congestion is said to consist in an accumulation of blood in the veins, though this is a very remote consequence. A better designation, according to my exposition of the pathology, and since venous congestion is assumed as a particular disease, I would say, for the sake of brevity and convenience, that its pathological cause is sub-inflammation of the veins; the accumulation of blood being only a remote effect. And so of active phlebitis, or of any other inflammation which derives its name from the part affected. Such, indeed, has become the specification of common inflammation in almost every part of the body. But, in all these cases, inflammation is an aggregate term which stands for that change in the organic properties which is the true pathology.

674, *c*. But what is the pathological cause, in the foregoing comprehensive sense, of other diseases, as fever, &c.? Here we have less light as to the nature of the changes, even of function; and hence there is less guide from general principles, and more abstract dependence upon symptoms and experience. Still, as will be seen, the pathology and treatment of fever are not without their important general precepts. We reach a knowledge of the modifications which the physiological laws undergo, and this is the most that we require for the institution of medical principles.

674, *d*. The vital states of a part or of the whole system may be variously modified in their condition so as to approach nearly to actual disease, and yet the modification fall short of the absolute change. This has been already seen in what I have said of predisposition to disease, whether accidental or hereditary. It is also constantly illustrated by the manner in which the heart sympathizes with every part which may be the seat of morbid action, and upon which the variable state of the pulse mostly depends. This prominent demonstration of sympathy by the heart may be carried to all other organs, which, in like manner, are liable to sustain sympathetic disturbances short of disease, but according to their own natural modification of the properties of life, especially of irritability (§ 133–136, 188). And, although these conditions do not amount to absolute disease in its common acceptation, they may reverberate morbific influences upon parts sus-

taining a greater lesion, and often call for the intervention of art (§ 714, 848). Or, such influences may give rise to severe forms of disease in other parts. Thus, gastric derangements, not inflammatory may induce severe inflammation of the mucous tissue of the throat, or hepatic or cerebral congestion, &c. (§ 500, 741 *c*). Again, certain morbific causes, acting upon the stomach, make their principal demonstrations in remote parts; as the narcotics, cantharides, &c. A simple element of this is constantly seen in the manner in which cold on striking the skin will develop catarrh, pneumonia, &c.; though, in the former cases, there may be specific relations of the morbific agents to particular parts, while in the latter, other predisposing causes may have operated (§ 147–151, 649 *c*, 657, 722 *b*). This principle lies at the foundation of all the consecutive developments which may spring up in different parts as the consequences of some primary derangement of a particular part, or of some local morbific impression which may come short of apparent disease in the organ impressed.

In sections 143, 666, 847, 848, I have endeavored to show how the whole system may be brought, sympathetically, into the foregoing condition, and how, in consequence, remedial agents will then exert a salutary effect upon all parts, when they might fail of any effect upon the same parts in their state of health; and how, also, in consequence of such remedial influences, the morbidly sympathizing parts may be made the sources of a reacting salutary effect upon the primary disease; as may, also, such as have not sustained a morbific influence (§ 514 *h*, 657 *b*).

675. As illustrative of some of the foregoing sections, particularly the last three, I shall now present an example of a therapeutical nature, but which takes, in its comprehensive range, the causation and philosophy of disease, the principle upon which morbific and remedial agents operate, whether directly upon the vital properties or through the medium of the nervous influence, the analogy between the operation of morbific agents and remedies, and how the last may prove, through a common principle, either remedial or morbific.

I shall assume, for the foregoing purpose, the intermittent fever, in which the whole system is engaged; and to simplify the treatment, bloodletting, nauseants, and quinine, may be the agents employed. Each of these agents, like all other therapeutical means, operate entirely upon vital principles, as set forth in the appropriate places in this work.

Now, without the aid of the philosophy which has been hitherto considered, we could not comprehend, in the least, any of the phenomena of this disease, much less their consecutive relations, as they are regularly presented at the several stages of the complaint; nor could we any better understand the salutary or the conflicting results of our remedial agents. But, the true philosophy of life places the whole subject in a consistent, intelligible, and even sublime aspect. At each of the several stages of an intermittent, the properties of life are in different states of modification, and the remedies must be adapted to their particular modification at the different stages of the disease; or such as may be curative at one stage will either fail of their effect at all other stages, or exasperate the complaint. In the first, or cold stage, the properties of life are profoundly altered; and, as this is the beginning of the paroxysm, the alteration has not ac-

quired that fixedness, or that influence of habit, which results from its prolongation (§ 535, &c.). Powerful impressions may, therefore, be made upon the morbid properties, and, if rightly made, they may at once arrest the paroxysm. But no remedy can be applied with safety at the cold stage which would add to the excitement if applied at the hot stage. No stimulants, therefore, not even quinine, which is so eminently curative during the intermission, can be employed in the cold stage without proving morbific, and an aggravating cause to the hot stage. But, many remedies which are appropriate to the hot stage will tend, more or less, if applied during the cold stage, to produce a change that will mitigate the hot stage, or bring on at once the sweating stage. Of the three remedies proposed, there are two which will often accomplish this result, and cut short the disease at this stage of the paroxysm, or at least conduct nature to an immediate consummation of her cure in the sweating stage. But, the nearer the beginning of the cold stage either of the two remedies are applied, whether loss of blood or an emetic, the more salutary, for the reason already stated, will be their effect. Numerous and striking examples of this important principle might be stated; as, for instance, an emetic will often subdue, at once, pneumonia or croup, if exhibited at their very invasion, when it may be perfectly powerless in a few hours afterward. And so, in a more limited sense, of the abstraction of blood, which reaches more profoundly and more universally all the organic properties, and determines upon them, when syncope approaches, a greater and more universal impression of the nervous power (§ 947, 948). This remedy, therefore, may often answer well at any period of the cold stage, should we determine upon its use.

But, suppose that the hot stage supervene. A new condition of the vital states has now sprung up, and it must be treated accordingly. Whatever will lessen and otherwise favorably modify irritability (§ 188, &c.), and contribute to the production of the sweating process, will be salutary at all periods of the hot stage, and whatever increases irritability and mobility will, as at the cold stage, exasperate the hot stage and embarrass the sweating stage. It is evident, therefore, that quinine will still prove morbific. But we have in certain nauseating remedies, as tartarized antimony, and in bloodletting, appropriate means for reducing and otherwise modifying the morbid state of irritability, in the hot stage. Alterative doses of antimony, even short of nauseating, may now exert a powerful tendency to bring about that favorable change which ensues naturally; while in its full emetic dose, so often favorable near the invasion, or at the onset, of the cold stage, this agent is rarely useful and frequently injurious. Abstraction of blood has the same useful tendency. But, this remedy, unlike its effect, and that of emetics, in the cold stage, will not operate with the greatest force at the beginning of the hot stage, but near the termination of this stage in the sweating process. The properties of life have now assumed a radically different condition. They are rapidly throwing off the influence of predisposition and of morbid habit, and their tendency is toward a restoration of their natural state. Nature is therefore more successfully aided in this new condition as she approaches the sweating or more curative process, which is the final cause of the hot stage. Hence it follows, where the advantage of one impression only can be had from a reme-

dial agent, although it be useful, like bloodletting, at other periods of this stage, it should generally be delayed, at least, till the stage of excitement has reached its acme. If cathartics be employed at this stage, they should be delayed, at least, till the sweating process has begun; and now an emetic may be sometimes salutary. But, the former, partly on account of their irritation, should rather be deferred till the sweating stage is over, while emetics are most salutary just before the invasion of a paroxysm, which, as in the hot stage, is always an inauspicious time for cathartics.

In proportion as nature is going on with a progressive march toward a comparatively healthy result, as in the sweating process, there should be no great interference from art. No help is wanted, for the restorative process will be soon spontaneously completed, and, at an advanced stage of this process, and before it is finished, there will be always danger of making some unfavorable impression, unless it be from remedies of a mild character, whose uniform result is that of acting as sudorifics, and coinciding in other respects with the changes which are in progress during the sweating stage. Such a remedy, for instance, is tartarized antimony, in doses short of nausea.

Finally comes the interval of repose, which is remarkable for its *specific*, but various, duration; giving to intermittent fever its quotidian, tertian, or quartern type. There is, however, notwithstanding the apparent state of tranquillity, very often some morbid condition remaining; as sufficiently denoted by any subsequent return of the paroxysm. In all such cases, there is a progressive change going on in the vital properties from the time of their comparatively natural state at the close of the sweating process toward that profoundly morbid alteration which constitutes the cold stage. The disease is again in a state of incubation, and therefore the tendency to change in the organic properties is exactly the reverse of what had just antecedently existed during the hot stage and its termination in the sweating process (§ 666). It is now the object of art to prevent a repetition of the paroxysm. This may be often accomplished by mere rest in a horizontal posture, and abstinence from all solid food; for the tendency of nature may be the right way, if she be not embarrassed by exciting causes; the slightest of which, as a shock of the mind, may throw her into a state of incubation. This shows not only the great susceptibility of the vital properties, during the intermission, to morbid changes, but, also, their frequent disposition to return, unaided, to their natural state. Should they require any other intervention from art than the mere act of withholding exciting causes, it is manifest, from what I have now said, that slight influences from remedial agents will be amply sufficient; so only we discard pernicious causes, and there be no severe local disease. The remedies for this purpose consist of a group that are called specifics, and have been suggested by experience independently of any general principles; so very peculiar is the state of the vital properties during the period of intermission. Of these specific agents the Peruvian bark and its alkaloids is one, arsenic another, and cobweb another; coming severally from each of the three great kingdoms, and each exerting nearly an equal control over the progress of incubation, but without any other known analogies to each other; certainly none of a chemical nature. The quinine, or arsenic, which would have been surely morbific at any other stage of the paroxysm, may

now be employed with a remarkably curative effect. But, a great error is often committed in exhibiting quinine, in this very tangible state of the organic properties, in excessive quantities; by which the disease is either prolonged, or the predisposition only temporarily subdued, or local affections induced or aggravated. As an invariable and important rule, also, just in proportion as the organic properties are approaching a state of health, so should our treatment be cautiously mild, or it will light up disease (§ 764. Also, *Med. and Phys. Comm.*, vol. i., p. 443, &c.).

676, *a*. In the foregoing section I have stated a problem for the specific object of showing the variety of changes which diseases are liable to sustain in their pathological character during a short period of their progress, and the importance of adapting the treatment to the changes which may ensue, with no other reference to symptoms than as they are indicative of the seat of disease and its true pathology (§ 762). But I have also, incidentally, at the same time, demonstrated the absurdity of attempting any part of the problems of disease, or the modus operandi of remedial agents, by any philosophy borrowed from the inorganic world, or by any hypothesis in the humoral pathology. The vital solidists, however, being numerically small, they must be little ceremonious with error; and once more, therefore, I shall bring into contrast the adverse doctrines (§ 350¼–376½, 433–450). With this intention I shall submit the philosophy as now taught in Great Britain and France, and leave it to the reader to interpret by that philosophy, if he can, the problems contained in the last preceding section.

676, *b*. It is scarcely necessary to remind the reader that Liebig's speculations in medicine are in general vogue in Great Britain (§ 349, *d*), and have become incorporated in medical works of every description (§ 433). Take the following example, relative to my present topic, from the long-celebrated and able, but now completely metamorphosed, PHARMACOLOGIA of Dr. Paris (§ 339, *b*).

"In a recent work by Professor Liebig, to which I have frequently referred," says Dr. Paris, "we are presented with views not only applicable to the question under discussion, but well calculated to extend our knowledge with regard to the modus operandi of contagious matter, and its reproduction in the living body. I have already explained his important application of the dynamic law of La Place to chemical action; viz., that a body, the atoms of which are in a state of transformation, may impart its peculiar condition to compounds with which it may happen to communicate."

Dr. Paris then proceeds to say, that it "was reserved for the genius of Liebig" to apply this doctrine of "fermentation," "putrefaction," &c., to the living body, in explanation of "the modus operandi of contagious matter," &c. I had occasion to set forth this philosophy of the Continental Chemist in my *Examination of Reviews*, together with the principal examples by which it was sustained (p. 55). Some of them occur, also, in the present work (§ 350, nos. 29 to 46, and 78 to 97). Of the "sausages," by-the-way (to illustrate the extent of acquiescence), it is said by Dr. Paris that, "by entering the blood, they impart their peculiar action to the constituents of that fluid, and *all the substances in the body are induced to undergo a modified putrefaction*" (§ 339 *b*, 349 *d*, 350, no. 44).

I shall not pursue this subject farther, having, in the *Medical and Physiological Commentaries* (vol. i., p. 385–716), devoted an Essay to the merits of the Humoral Pathology, where all the foregoing points, the "sausages," &c., are duly investigated (§ 282).

And now to complete this example of sudden and general illumination, and to exemplify, again and again, "the recent progress of medical science" under the auspices of "experimental philosophy," let us hear Dr. Paris as he was, at a former edition of his Pharmacologia, and when he and others were just as much enlightened as to the connection of chemistry with the healthy and morbid processes of man, as when he put forth the ninth and last edition of that distinguished work. Thus:

"Every *rational* physician must feel, in its full force, the *absurdity* of expecting to account for the phenomena of life upon principles deduced from the analogies of inert matter; and we therefore find that *the most intelligent physiologists of modern times* have been anxious to discourage the attempt, and *to deprecate its folly.*"

In descanting upon the interference of the celebrated chemist, Mr. Brande, with medical topics, Dr. Paris remarked, that

"*Whenever the chemist forsakes his laboratory for the bed-side,* HE FORFEITS ALL HIS CLAIMS TO OUR RESPECT AND HIS TITLE TO OUR CONFIDENCE" (§ 709).

III. SYMPTOMS.

677. *Symptomatology* is the third and last division of pathology; being the doctrine of *symptoms.* It embraces all the phenomena which result either directly or indirectly from morbid states, and includes, therefore, the physical as well as vital signs (§ 883).

678. During the healthy state of the vital properties, all the results of life progress in one uniform way, according to the nature of the several parts of the organic being (§ 249). But, as soon as the properties of any part undergo changes, there arise corresponding changes in the motions of the vessels, and in all the phenomena and products (§ 177).

679. Now it is owing to the intangible, invisible nature of the efficient causes of all phenomena, that we are compelled to apply ourselves to the study of the phenomena to obtain a knowledge of the powers or properties upon which they depend, the modifications which the powers or properties may undergo, and the laws which they obey. It is obvious, therefore, that the nearer the phenomena are to the direct operation of the causes, the more significant will they be of their nature and existing condition. This undeniable fact shows us the superiority of the primary effects of disease, as a guide to pathological conditions, over those ultimate results which are disclosed by morbid anatomy.

680. In entering upon this inductive branch of pathology, it is important to bear in mind, that, however complex the nature and variety of symptoms, they have always as much an absolute cause as any effect in the inorganic world; and I am led to this remark for the purpose of adding another,—that it is of incomparably greater importance to ascertain the former than the latter. When motions are disturbed in the subordinate kingdom, it is the first impulse of reason to trace out the cause; but that is the measure of its compass. The Power

that gave to matter its being, or natural influences, can alone rectify the cause. But, how different with organic nature! How expressive of the radical distinction between the causes of motion in the dead and the living world! In the latter, all is fluctuating in its nature, yet all controllable in that very nature by the hand of man. We see in the principle of life the cause of organic results. We see those results vacillating in every possible aspect; and, as with the chemist, or the astronomer, in the former case, we interrogate the cause. But we do so with a far higher aim; for we know that the cause is amenable to rectifying influences. In the world of matter and in the world of life, the causes of erratic phenomena may be on a par, in principle. The disturbing influences may be alike due to a common cause, in each department, respectively. But, in the mineral kingdom, there are numerous fundamental causes in operation, and the phenomena, therefore, may depend upon opposing influences. In the organic, from the mushroom to man, there is but one cause; and hence the obvious induction that certain changes in the natural condition of that one give rise to all those diversified effects which form the transient phenomena of disease, or those more stable changes which are seen in the progress of the being from its embryo to its adult state, or in the vicissitudes of temperament, &c.

We therefore apply ourselves, I say, to the cause itself; and here all analogy disappears with any known cause in the inorganic kingdom. The former is changeable in its nature, and as the changes go on, its existence comes to an end. But the same First Cause Who imparted that instability for great and wise purposes, ordained, also, that when the principle of life should be diverted from its natural condition by untoward agents, it should still possess, through the same law of mutability, a capacity of receiving impressions from other agents that shall awaken its inherent tendency to a state of integrity.

In tracing out the nature and the seat of disease through the attendant phenomena, we are also animated with the conviction that organic beings are subject to laws as precise as those which rule in the inorganic world, under all their fluctuations; and the greater complexity in the elements of their laws than such as relate to physics and chemistry should stimulate the most exact investigation of symptoms wherever nature may demand the active interference of art (§ 237, 447 *b*).

681, *a*. The symptoms, or effects to be employed as guides to the nature and seats of disease, are, 1st. Those which are denominated vital signs, and which are independent of physical products. 2d. The changes of motion and other conditions relating to the vessels which are the instruments of disease, but which are independent of structural changes. 3d. The physical products which are comprehended under the denominations of secretions and excretions. 4th. Symptoms of the foregoing nature which are determined or modified by changes of organization, and about which morbid anatomy is interested. 5th. Signs of a physical nature which depend upon either some change of structure, or on the accumulation of fluids, or the presence of some unusual fluid, or other substance, within the body. These last signs come to us principally through the medium of sound and touch. The first three of the foregoing classes of symptoms may be denominated *primary*, the last two *secondary*.

681, *b.* The five divisions into which I have distributed the symptoms of disease, and the remaining facts which we derive from morbid anatomy, and what we learn from remote causes, and the effects of remedial agents, supply all the knowledge we can obtain of the pathology of disease.

681, *c.* We must, therefore, constantly concern ourselves about effects, whether investigating the natural world, the powers by which it is governed, or spiritual existences.

Symptoms, then, are the language of disease, as effects are of all other real existences.

682, *a.* Certain symptoms are called *diagnostic.* By these, in part, we distinguish diseases from each other. A symptom, therefore, to be diagnostic, must be peculiar to one affection. Thus, hydrophobia is the diagnostic symptom of the disease which is called, like some other affections, after the name of its diagnostic. But it is only peculiar to the disease as it affects the human species. The diagnostic of intermittent fever is the intermission between the paroxysms; and so of their attendant intermittent apoplexies; and paroxysmal increase of those inflammations that are relieved by bark, and the intermission of periodical headaches, and of tic douloureux, are their diagnostics.

682, *b.* Some diseases may have several diagnostic symptoms. Thus, in pneumonia, a good diagnostic is found in the tenacity of the mucus. Another diagnostic is the crepitating noise which is heard on applying the ear to the chest. The first symptom, however, is often absent; and the other is not always present, especially in infants. The crepitus, also, disappears when condensation of the air-cells takes place, and this disappearance is diagnostic of condensation. But if the patient recover, the condensation generally disappears, and while the process of absorption is going on the crepitus returns, and this is diagnostic of the absorption. Many diagnostics are supplied by auscultation as to the particular parts which are affected in diseases of the heart, and which are significant of the precise nature of the affection. And so of the lungs. Percussion has also its peculiar diagnostic signs. We are doubtful, for instance, whether a tumid state of the abdomen be owing to flatulency or to something else. A hollow sound, on percussion, assures us that it depends, in part, at least, upon the presence of some gaseous substance.

682, *c.* Many diseases have certain symptoms which are nearly always present at certain stages of their progress, but are more or less attendant on some other affections. This is the case with the hectic fever of consumption. In such instances the other attending symptoms will determine whether the prevailing one in any particular affection is significant of that disease in the case before us. Incompressibility of the pulse is perhaps always significant of inflammation; but it often requires much skill to detect it. The attendant hardness of the pulse may be then taken as a good diagnostic; but this also is often ascertained only by a delicacy of touch, and may not be always distinguished from the pulse of pregnancy. An auxiliary diagnostic will then be found in a buffiness of the blood; but here, too, that appearance is often presented by the blood of pregnant females. There then remains an unequivocal diagnostic of inflammation in the associated cupping and fimbriated edges of the blood (§ 688, *d, e*).

On the other hand, there are many affections which have no diag-

nostic symptom; and we must then rely upon the combined symptoms, the remote causes, &c.

682, *d*. Such, then, are symptoms which impart a general apprehension of the nature of disease, or of its variations, &c. They serve as an aggregate of the other attending phenomena, and, in a general sense, should be employed only as starting points to a critical investigation of those numerous details which may alone conduct us to a knowledge of the extent and force of disease, its complications, &c.

683. There are other symptoms which are called *prognostic*. It is by these, in part, that we judge of the degree of danger, and of the probable issue of disease. Hence arise the terms *favorable* and *fatal*, and various other expressions of an intermediate import.

684. We acquire our knowledge of symptoms, or deviations from the natural states of the body, by comparing the former with the phenomena of the latter; and we distinguish diseases from each other, and learn the changes which are in progress, by comparing symptoms with each other. By the same system of comparison we judge, also, of the effects of remedies, form our prognosis, &c.

685. It is evident, therefore, that the young practitioner, at least, should acquire a habit of methodical analysis of disease, with a steady view to its pathological cause, and the successive changes which may arise in respect to this cause (§ 673, 675). He should begin,

1st. With an inquiry into the natural temperament of the subject, his age, habits, &c.

2d. Make a general survey of the symptoms, the organs from which they spring, their general aspect, number, variety, &c.

3d. In all cases of severity, the remote causes should be ascertained as far as possible.

4th. All the great organs should be next critically interrogated, that the primary seat of disease may be ascertained and understood, and how far it may have involved, by sympathetic influences, other organs, both in their compound nature and in their individual tissues (§ 133, &c.), and how far, also, the sympathetic results may react upon the primary disease, or institute sympathetic influences among themselves.

This inquiry embraces all the vital signs, the state of the secretions and excretions, and the physical signs afforded by auscultation and percussion. The countenance, the organs of sense, and all that relates to the external body, the state of the tongue, pulse, &c., should come under review.

5th. A careful comparison of all the symptoms should be instituted with the analogous phenomena in health; with the symptoms of the same disease as it may affect other parts; with the symptoms as they may have been observed in various degrees and at different stages of the same malady; with the symptoms of convalescence; and with such as follow the action of medicines; and with the symptoms of other diseases.

6th. Inquire into the mode in which the symptoms occur, whether suddenly or gradually, distinctly or confusedly, &c.

7th. Consider their progress, their changes, the mode of their progress, &c.

8th. Examine the relation of different symptoms to each other; as, their relative duration, order of occurrence, &c.

9th. Calculate the degree or force of the symptoms; a point of difficult attainment, requiring a correct appreciation of the properties of life, a profound knowledge of physiology, an extensive acquaintance with its modifications in disease, habits of a close analysis of symptoms, much thought, and a well-disciplined mind. To one thus qualified the eye of the patient alone may be a luminous index to the degree or force of the general symptoms (§ 163, 714).

686, *a*. And now, as a consummation, next to the direct application of remedies, of all that has been hitherto submitted to my reader, as immediately indispensable to the ultimate aim of all that has been said, and without which the Institutes of Medicine would only serve as an intellectual exercise, I shall introduce a practical example, as a general standard for investigating any given form of disease with a view to its treatment (§ 714).

686, *b*. Let us, then, suppose ourselves called to a case of idiopathic fever of some three or four days' duration, in which, from the length of its continuance, there have probably arisen some local inflammations, and, perhaps, venous congestions.

We proceed, according to the foregoing method (§ 685), to inquire,

1st. Into some general facts, and take a general survey of the case. We inquire how long the patient has been sick, with what symptoms he was attacked, what new ones have subsequently sprung up, whether they have undergone an increase in the afternoon, and a decline toward morning, whether the attack was preceded by unusual sensations, or by any signs of beginning disease, what is his age, constitution, habits, &c. The knowledge thus acquired gives us a general apprehension of the nature of the case, and we come, at once, to the conclusion, that it is a case of idiopathic fever, affecting an individual of a certain age, temperament, habits, &c. This leads us to inquire,

2d. Into the nature of the predisposing causes (§ 662), and as they are atmospheric (§ 648, *b*), we ascertain his place of residence for a few preceding months. We find, perhaps, that he has lately come from a city where yellow fever prevailed, or had resided from one to six months ago where typhus was rife, or where it is known to occur, or from one to twelve months since he had been in some marshy district, or upon some new rich soil, where the remittent fever delights; or, there may be reason to suppose that the causes originated in the place where he is attacked. A knowledge of any of these facts, whichever may be true, goes far in ascertaining the particular modification of fever he may suffer (§ 650–653). Let us suppose him an Irish emigrant, just landed in New York. We suspect at once typhus fever, though we have no such fever originating with us. It is a very common form of fever, however, in Ireland; and we learn farther from our patient that it prevailed in his neighborhood when he left that country. This knowledge influences our subsequent inquiries, when we proceed,

3d. To inquire specifically into the symptoms attendant on all the organs, and to compare them with the natural phenomena of each. We begin where they are most strongly pronounced, and pass from one organ to another as may be suggested by the most obvious symptoms, or as they may seem to be related by sympathetic influences (§ 660). The disease being typhus, the brain, or its membranes, are probably the seat of inflammation or venous congestion. We inquire

as to headache, whether obtuse or acute, in what part of the head, &c.; whether there be drowsiness or wakefulness; whether there be an unusual pulsation of the carotids, or of the temporal arteries, or an exalted temperature of the head; whether the face be suffused with blood, and if so, whether the plethora be in the arteries or veins,—being florid in one case and purplish in the other. We look critically at the eyes, observe how their lustre or other expression is affected; whether the pupil be dilated or contracted, and, if the sight be dim, we inquire whether it be owing to an affection of the retina, or how far to actual cerebral disease or to sympathy of the eyes with any gastro-intestinal derangement; whether the conjunctiva or the eyelids be red or purplish, whether moist or dry, &c. We attend to the hearing, whether dull or acute; observe how far speech may be affected, and how much any impediment may be due to cerebral disease, or to dryness of the mouth, or to inattention, &c. These inquiries relative to the senses should be accompanied by others respecting the mind, whether memory be much affected, perception and reflection impaired, whether there be hallucinations when awake, or talking in sleep, and whether sleep be comatose, or how long continued, &c. These inquiries may leave little doubt that there is both inflammation and venous congestion within the head, which will be cleared up by an investigation of symptoms relative to other organs (§ 803, &c.). Our attention may be next attracted to the chest by cough, or some embarrassment of respiration. We inquire when the cough began, what its frequency and severity, how far it may be independent, in its origin, of other local burdens of disease, or how far consequent on abdominal affections, and whether attended by expectoration, and what the nature of the matter expectorated. We count the respirations, and observe their equality or inequality. We see, perhaps, that the brain influences the respiration unfavorably, especially if slow, and this adds to our conviction that mischief exists in the head; or, if the breathing be hurried, it may be due to febrile excitement, or to abdominal derangement. The cough and expectoration show us that some inflammatory action is going on in the lungs; but we are doubtful, perhaps, on account of some thoracic pain, and as the sputa is rather adhesive, whether inflammation be confined to the mucous membrane of the bronchi, or have reached the air-cells and cellular tissue, and thus constituting pneumonia. We therefore resort to auscultation and percussion to resolve the doubt. From the former we learn that there is no crepitus, that the murmur is clear and free, and there is only a mucous râle; by percussion, we find that the resonance is good, and we therefore dismiss our fears as to the possible existence of pneumonia, or of tubercle. But the patient complains of pain in his chest. We ask him to breathe deeply, and the pain is much increased, as it is also on coughing. From this symptom, and the absence of pneumonia, we are sure of the existence of inflammation in the pleura, while the cough and expectoration tell us of catarrhal inflammation in the pulmonary mucous tissue.

It is now time to feel of the pulse, to learn how far the heart sympathizes with these local inflammations, since the extent of the influences determined upon the heart may show us considerably the severity of the local inflammations. But this organ is also under the influence of the general idiopathic disease, and it is often one of the nicest

points to determine how much of its character is due to the febrile affection and how much to local burdens of disease. And the difficulty is enhanced if influences are directly propagated abroad by cerebral disease. We find the pulse, perhaps, not so hard or full as we had expected, and this leads us to infer more of venous congestion than of ordinary inflammation of the brain; or, that there may be venous congestion in some other organ not yet examined, since these congestions are very apt to spring up in typhus, and to moderate a hardness of the pulse which the coexisting inflammations of the membranes of the brain and lungs would otherwise produce (§ 815, &c.). Perhaps we discover, also, in the pulse, some intermission or other irregularity in its stroke. This may be owing to some organic affection of the heart, and to resolve this doubt, we again resort to auscultation. We find, however, all the sounds good, and we are now led by the foregoing symptom, along with the subdued hardness of the pulse, and its want of any great incompressibility, to suspect venous congestion of the liver, since intermission and other irregularities of the pulse, without organic disease of the heart, commonly depend upon that state of hepatic disease, though, also, on cerebral inflammation; but in the latter the pulse is more frequent than in the former case, when, also, in the absence of fever, it is often preternaturally slow; or, if slowness of pulse depend on venous congestion of the brain, as it sometimes does, the respiration is also apt to be slow, while it is unaffected in simple hepatic congestion (§ 390, *b*). We then take the liver next in our range of inquiry. We find, perhaps, some obscure tenderness on pressing its region, and the patient may have had some pain in this quarter. We then look at the skin, to see whether there be any shade of yellow, and when our cathartics operate, we examine the discharges with various references, but particularly as to the state of the hepatic secretions. If they are blackish, or green, this strengthens our conclusion as to congestion of the liver, though the congestion may be so profound that little or no bile is secreted. This condition of the liver, however, is more apt to attend remittent, intermittent, and yellow fevers. We observe whether there be a redundancy of intestinal mucus, as this would denote some inflammation of the mucous tissue, and has often an important bearing upon the treatment of the case, as does also that irritable state of the intestine which is denoted by the diarrhœa that often supervenes in the progress of typhus fever. We look at the urine, and find it perhaps scanty, scalding, very high-colored, and depositing a sediment. This, however, would imply nothing distinctly, but that the kidneys suffer in their powers and functions, though great scantiness of urine and a high color would denote a considerable burden of disease upon one or more important remote organs, and those particularly the digestive organs. We now turn our attention more particularly to the alimentary canal, partly with a reference to its morbid state, and in part to aid our judgment in the right administration of medicines. Here, too, we may find a great focus of morbid spmpathies, great influences radiating from the gastro-intestinal mucous membrane, lighting up inflammations or congestions of other parts, or maintaining and aggravating such as may have sprung from other causes, and sustaining itself reverberated morbid sympathies (§ 514 *h*, 647, 660). We press, for example, the region of the stomach, to learn whether it be

tender, and in like manner examine the whole, or special regions, of the abdomen, if there be pain or uneasiness in the intestines, &c., and we make percussion to see if there be flatulency. We inquire what food the patient has recently taken, and whether the bowels have been constipated or loose. In all this part of the inquiry we are often greatly aided by the appearances of the intestinal evacuations, which should be carefully observed throughout the continuance of disease (§ 694½). We also examine the tongue with a reference to several objects, but especially with a view to the condition of the stomach and intestines. We notice its color at its edges and in the centre; whether coated, and how extensively, and what the color of the coating in its different parts; whether light and loose, smooth and rough; whether dry and moist, and the extent of each; whether the tongue be enlarged or contracted, pointed or obtuse, smooth or indented at its edges, what its color, &c. We look at the fauces, to learn if they be red or purplish, as indicative of inflammation or venous congestion, or other derangement in the important organs below; observe whether there be glutinous matter on the teeth, and what its color, and the rapidity with which it may collect.

We now turn our attention more distinctly than before to the functions of the skin; whether it be dry or moist, or each alternately, and the duration of each, whether hot, warm, or cold, and at what times, and how long, whether the heat be distributed equally, whether the feet be cold when the rest of the surface is hot, whether the skin be rough or smooth, what its color, whether there be "sudamina," "rose-colored spots,"* &c.

The patient may require the loss of blood, and we observe its color, whether dark or florid, the manner in which it flows from the arm, whether in a full stream or whether it trickle, whether it throw up a buffy coat, be indented or cupped in its centre, or fimbriated at its edges; and, that these observations may be perfect, we take an ounce in a wine-glass for examination (§ 682 *c*, 688 *e*).

If, in the case of fever now under examination, there be a predominating influence of the venous congestions over the membranous inflammations, the blood will be dark, will trickle from the arm, or flow in a languid stream, at first, and will throw up a buffy coat, without as much indentation as when membranous inflammation exists without venous congestion.

686, *c*. The foregoing analysis of symptoms is, to the young practitioner, necessary to a clear apprehension of many severe diseases, but must be more or less varied according to the nature of the disease. It may be apparently tedious, but is accomplished with rapidity by a little practice. Nor have I stated all the inquiries which should have been instituted, and which may be of essential moment. Thus, it may be necessary to call in the aid of smell to ascertain whether any fœtor we may observe come from the mouth, or stomach, or lungs, or from the surface of the body. The patient may also supply a variety of facts as to his sensations,—whether restless, weary, prostrated in his voluntary muscles, what as to pain, or sensations of heat, chilliness, &c. We vary his posture, to learn how it may affect respiration, or the state of his pulse. I have also left out of my examination of the

* See Essay on the Writings of Louis, in *Medical and Physiological Commentaries*. vol. ii., p. 724, &c.

foregoing case an inquiry as to the mode in which the symptoms took place,—whether suddenly or gradually, distinctly or confusedly, whether they began with a chill, or with a paroxysm of heat, &c., about which the patient should be specifically interrogated. Nor did I examine sufficiently the relation of the different symptoms to each other, as their relative duration, their order of occurrence, &c., by which we ascertain which organ was first inflamed or congested, and what others are more or less affected by sympathetic influences. And there yet remains to be considered the progress of the symptoms, their mode of progress, their spontaneous changes, or such as may arise from incidental exciting causes, or from the action of remedies, &c., and, also, their comparison with those of other modifications of fever, or other forms of disease. I said nothing, specifically, as to an inquiry into the degree or force of the symptoms, which is always a subject for accurate consideration, as it goes far in denoting the severity of disease in different parts, and is one important guide to the nature and extent of the remedies. But this is an attainment, as already implied, which cannot be imparted by a description of symptoms, since their force cannot be expressed in language. Their estimate must come, as it were, by intuition (§ 683, no. 9, 762).

686, *d*. In proportion as our knowledge of physiology enlarges, and we apply it to the investigation of disease, the practice of a minute analysis of symptoms becomes less and less necessary. But, to acquire this professional tact or skill, we must first go through the school of elementary instruction and practice. But industry will at last triumph, and what seemed at first obscure in diseases may become luminous at a comparatively superficial view. We then begin to neglect, more or less, many of the minutiæ. We confine ourselves more to the most prominent or characteristic symptoms. The countenance alone may tell us of a labyrinth of disease. But, it will still often happen that no prominent symptoms are present, and it may then be necessary to go into the details; or they may be so confused and indistinct as to render us undecided as to the seat or the nature of the disease, till other symptoms are developed. This may be illustrated by the growth of a plant. When it first emerges from the ground, it may have no specific characters by which we can determine whether it be destined for a tree or a weed. We must therefore await the development of its characters, which, if it continue to grow, it will certainly put forth. There is often an obscurity of a like nature, in diseases, at their early invasion, and even when profound. The soundest judgment may be baffled in the adaptation of certain remedies; and if these are to be administered internally, especially if active, no risk should be taken, but farther developments awaited.

OF CERTAIN SPECIAL SYMPTOMS.

687. It had been my purpose to have limited my remarks to the general principles which respect the present branch of my inquiries. But, in consideration of what I shall say of the pathology and treatment of inflammation, venous congestion, and fever, as also on the subject of bloodletting, I have determined to express my own views as to some of the symptoms which take a prominent rank in diseases. It is also my desire to associate the results of disease with the philosophy which concerns them, that these important sources of pathological

knowledge may be studied in connection with those inquiries which distinguish the philosophical physician from the mere empyric (5½, *a*).

The Pulse.

687½. There is one system of organs, particularly, whose actions are so constantly modified by sympathetic influences, and whose phenomena are universally employed in estimating the nature, force, &c., of all diseases, and at all stages of their progress, and which are also elementary in denoting the effects of remedies, especially of loss of blood, that I shall make a general analysis of the prominent characteristics. We generally learn the influences exerted upon this system of organs by the varying states of the *pulse*, and the radial artery affords the best opportunity for this purpose, though the pulse may be often advantageously examined in other places. Thus, in inflammations and congestions of the brain, it is useful to learn how far the pulsation of the carotids may be specifically affected. So, in similar affections of the liver, we attend to any unusual pulsation of the aorta in the region of the stomach. In all such cases, irritations are apt to be propagated by continuous sympathy along the principal communicating arteries, by which their action is more or less increased (§ 498). It may be also important, sometimes, to examine the heart itself, especially when it may be suspected of being the seat of absolute disease; and, although the pulse be generally regulated by the action of the heart, the arteries, as we have now and before seen, are liable to independent influences, and the pulse, therefore, may be sometimes deceptive in one or in both radial arteries. If there be inflammation of the hand or arm, we shall be very likely to find the pulse on that side with greater characteristics of disease than on the other; and differences will arise from mere differences in the size of the arteries. In inflammations and congestions of the brain, the nervous influence will often exert an effect, less common in similar affections of other organs, upon the capillary vessels, and this effect is sometimes strongly pronounced by an inequality in the radial arteries (§ 929–936, 973, 974). In various forms of disease the heart sometimes beats with greater force than is denoted by the pulse at the wrist, and sometimes the pulse is very voluminous without a corresponding action of the heart. (See *Medical and Physiolog. Comm.*, vol. i., p. 236.)

688, *a.* When the radial pulse is examined, the four fingers should be applied along the course of the artery, and various degrees of pressure should be made. The blood taken for examination should be received into a wine-glass, and, if possible, in a full stream.

688, *b.* Certain general conditions of the pulse worth noticing are the following:—its *quickness*, *slowness*, *frequency*, *hardness*, *softness*, *incompressibility*, *compressibility*, *fullness*, *smallness*, *strength*, *weakness*, *obstruction*, *freedom*, *intermission*, *redoubling*, *trembling*, and *other inequalities.*

688, *c. Quickness.*—This term does not stand in opposition to *slowness*, although it is generally so considered. *Frequency* is the opposite of *slowness.* Quickness arises from the systole of the heart occupying less time than its diastole; so that a *quick* may be a *slow* pulse. The stroke is then sudden, the dilatation more prolonged, with an interval somewhat distinct. A *frequent* pulse, on the contrary, is always what the term denotes. The systole and diastole of the heart succeed each other rapidly, and in about equal times.

A *slow* pulse is, also, like a *frequent* one, uniform as it respects the systole and diastole, both of which are prolonged. It is most apt to be attendant on chronic venous congestions, though, as the affection advances, or undergoes any sudden increase, it may become *frequent*. When *slow* in such conditions, the pulse is also often intermittent or otherwise irregular, and if it subsequently become frequent, the irregularities are apt to disappear. Venous congestion is always to be suspected, and especially in the liver, when the pulse is preternaturally slow, without other manifest signs of disease (§ 390, *b*).

Quickness of pulse is not an important symptom, in a general sense.

688, *d. Hardness* and *Softness*.—These terms stand in opposition to each other. *Softness* is a natural state, and *hardness* a morbid one; though a pulse may be preternaturally *soft*. *Hardness* of pulse is one of its most important modifications. In nearly all cases it is indicative of inflammation, and no considerable inflammation can exist long without producing it. It appears to depend upon some direct modification of the action of the vessels, and not connected with that of the heart; the nervous influence being determined in a peculiar manner, by inflammatory affections, upon the whole arterial system (§ 226, 233, 973, &c.). The term *hardness* may be well understood by comparing the sensation to that which is produced by a solid rod rising simultaneously, and not successively, against the four fingers.

688, *dd. Hardness* is often confounded with *strength* and *fullness;* but the three symptoms are very different from each other. A *hard* pulse is perfectly compatible with *smallness* and *weakness;* the former of which is seen especially in peritoneal inflammation of the intestine, and in pulmonary consumption; the latter in unsubdued inflammations after repeated abstractions of blood, and often in congestive fevers, and in phlebitis. To distinguish the *hardness* fully, in these latter cases, requires a careful regulation of the pressure; scarcely more than a gentle touch with the four fingers. Greater compression may extinguish the symptom, and the pulse may even appear to be soft. The distinction is often of great importance, especially in congestive diseases, as upon it may depend the decision of those who are apt to be governed by the state of the pulse, in the important matter of bloodletting (§ 961–965, 971).

688, *e. Compressibility* and *Incompressibility*.—*Incompressibility* of pulse is probably peculiar to inflammatory conditions, and one of the most uniform characteristics of the pulse when such conditions invade the general circulatory system by sympathetic influences. But when inflammation is fully overcome, especially if general bloodletting have been freely practiced, the pulse is often more easily compressed than in health. So long, however, as the disease continues to affect the general circulatory system, that peculiar characteristic remains, in various degrees, unless the remedies be very depressing, or the powers of life verging toward a state of extinction. But, as might be expected from what I have said of *hardness* of pulse in venous congestions, *incompressibility* is less marked in all forms of venous inflammation than in equal conditions of inflammation of other tissues. Here, too, as with *hardness* of pulse, the observer is very liable to be deceived; since the general volume of the pulse may give way under a slight pressure, and yet the pulse be incompressible (§ 688, *d*).

The proper method of ascertaining this symptom, in doubtful cases,

is to make a hard pressure with one finger, and a moderate pressure with another on the distant side, when a thread-like stream will be felt by that finger.

Hardness and *incompressibility* generally demand the loss of blood; though whether local or general, and the necessary extent, must be determined by other symptoms; the extent, especially, by the effects produced during the operation of general bloodletting.

688, *ee.* Coincident with *hardness* and *incompressibility* of pulse, and almost peculiar to inflammation, is the *buffy coat*, with its depressed centre, and often fimbriated edges. The buff which forms on the blood in pregnancy is due to the increased vascular action of the uterus, and a modification of its vital properties not very dissimilar to what obtains in some varieties of inflammation, and is the groundwork of those active forms of the disease which so often beset the uterus and other parts in the early stages of childbed; and should the indented centre and fimbriated edge make their appearance, we shall scarcely fail of deriving farther confirmation of the actual presence of inflammation in an attendant hardness and incompressibility of the pulse, and probably, also, in some local symptoms. And so of the buff which is sometimes apparently consequent on violent exercise; but more probably dependent upon some obscure inflammation. We may not trust, in these rare instances, to the carelessness of many observers, and the incapacity of others, while the fact should not be neglected that this exception to a significant indication for loss of blood has been raised by such as are adverse to the use of the lancet in the treatment of inflammation.

The indentation, or cupping, is generally less strongly pronounced after each abstraction of blood, and may disappear altogether, under the lancet, before the inflammation is subdued.

The fimbriated edge is most common where inflammation is severe, and has established a strong sympathetic influence upon the general circulatory system. In such cases, also, it will often continue to occur after the cupping ceases to be formed.

Like hardness and incompressibility of the pulse, the buffing and cupping of blood, for reasons already stated, are less strongly marked in venous congestions than in membranous inflammations.

The formation of the buff, and the central depression, and the fimbriated edge, are remarkably affected by the shape of the vessel, and by the manner in which the blood flows from the veins. A shallow vessel is the worst, the form of a wine-glass the best.

688, *f. Fullness* and *Smallness* of pulse.—These terms are also in opposition, and both may imply a preternatural state of the pulse, being now employed in their morbid acceptations. *Fullness* is also synonymous with *largeness.*

These morbid states of the pulse are owing to sympathetic influences determined both upon the heart and arteries. The extent of these influences upon each other is very variable, and must be judged of by direct examination of the pulse at the heart and extremities.

It does not necessarily follow that an unusual quantity of blood is sent out by the heart, since the volume of the arteries may depend greatly upon a direct expansion of the vessels. So in a small pulse, the direct morbid influences may be more upon the arteries than upon the heart, by which the vessels are held in a contracted state.

This is especially seen in the cold stage of fever, and in peritoneal enteritis. It is also seen in the depressing states of venous congestion. In all such cases, an influence is propagated from the arteries to the heart, by which, as well as by other influences, its action is accelerated; or, if not accelerated, then the blood accumulates in the venous system, especially about the right cavities of the heart. In all these cases there is a profound interchange of sympathies well worthy an inquiring mind (§ 222, &c., 514 *d*, *k*, *l*, 914–919, 929–936, 973, 974).

Smallness of pulse is generally a much more important symptom than *fullness;* commonly implying the presence of greater evil. Connected with hardness, it is always bad, when it is also *frequent.*

688, *g*. *Strength* and *Weakness.*—I have already remarked that these symptoms are often mistaken for *hardness* and *softness.* They depend, principally, upon sympathetic influences that are exerted upon the heart by remote organs, though certainly not altogether. It is doubtful, indeed, whether any sympathetic influences are ever exerted upon the heart without being simultaneously extended, more or less, to the arteries; especially to the capillary series (§ 481–485, 973, 974). But, all parts of any one division of the arterial system may not be equally affected, or one part may be sensibly affected and not the rest, as in blushing, and as in § 687, *c*.

688, *h*. *Obstruction* and *Freedom.*—*Obstruction* is an obscure condition of the pulse which it is difficult to describe, but is recognized in practice. It is not easy to know its cause, as it probably does not actually arise from any obstacle to the passage of the blood, though it may be owing to a want of harmony between the action of the heart and the capillary blood-vessels (§ 386).

688, *i*. *Frequency* and *Slowness.*—These are two very important symptoms in some of their morbid aspects, and are often replete with information, especially as to the force of disease and the degree of danger.

To ascertain these characters, the patient, for obvious reasons, should be at rest; and if a child, should be asleep.

No writer has so well described the conclusions to be derived from a *frequent* and *slow* pulse as Dr. Heberden, in his "Commentaries." From their importance, and as I cannot improve Heberden's description, I shall quote it.

"The pulse of a healthy infant asleep," he says, "on the day of its birth, is between 130 and 140 in a minute; and the mean rate of the first month is 120. I have never found it beat slower than 108. During the first year, the limits may be fixed at 108 and 120. For the second year at 90 and 108. For the third year at 80 and 100. The same will very nearly serve for the fourth, fifth, and sixth years. In the seventh year the pulsations will be sometimes so few as 72, though generally more; and in the twelfth year they will often be not more than 70; and, therefore (except only that they are much more easily quickened by illness, or any other cause), they will differ but little from the healthy pulse of an adult, the range of which is from a little below 60 to a little above 80. It must be remembered that the pulse becomes more frequent, by 10 or 12 in a minute, after a full meal.

"If the pulse either of a child, or an adult, be quickened so as to

exceed the utmost healthy limit by 10 in a minute, it is an indication of some little disorder. But a child is so irritable, that, during the first year, a very slight fever will make the artery beat 140 times, and it may beat even 160 times without danger [Heberden meaning either idiopathic fever, or the constitutional effects of inflammation]; and, as there begins to be some difficulty in counting the pulse when the motion is so rapid, the thirst, quickness of breathing, aversion to food, and, above all, the want of sleep, enable us, better than the pulse, to judge of the degree of disease in infants.

"If the pulse of a child be 15 or 20 below the lowest limit of the natural standard, and there be, at the same time, signs of a considerable illness, it is a certain indication that the brain is affected, and consequently such a quiet pulse, instead of giving us hope, should alarm us with the probability of imminent danger.

[An important exception to the foregoing remark is frequently presented by venous congestions of the liver, when the pulse may be equally diminished in frequency, but not indicative of present danger.]

"In adults ill of an inflammatory fever, the danger is generally not very great where the beats are fewer than 100;—120 shows the beginning of danger; and they seldom exceed this number unattended with some deliriousness. There are two exceptions to this observation. The first is, that before some critical swelling or deposit of matter begins to show itself in fevers, the pulse may be so rapid and indistinct, as hardly to admit of being counted; and I have known it certainly not less than 130, and yet the patient has recovered. And rheumatism affords a second exception; in which the artery will often beat above 120 times without any sort of danger.

[Those exceptions are relative to inflammation as limited to parts unimportant to organic life. They are presented, also, in other instances of this nature, and in intermittent fever.]

"In an illness where the pulse all at once becomes quiet, from being much accelerated, while all the other bad signs are aggravated, it is a proof, not of a decrease of the disorder, but of the lessened irritability of the patient, and that the brain has become involved in the disease.

"In low fevers, and in exhausted old men, the pulse will often continue below 100, or even 90, and yet the disease be attended with want of sleep, deliriousness, restlessness, and a parched tongue, and end in death, without any comatose or lethargic appearances.

"A pulse increased in frequency more certainly denotes danger than a natural one does security, where disorders of the viscera are suspected."

Finally, in countries where local congestions of the liver occur, as in the regions of intermittent and remittent fever, the pulse often falls, in hepatic congestions, far below its natural frequency. Considered abstractedly in these cases, and often in the preceding, it affords but little information as to the force of disease. There may be great danger, or but very little, when the pulse is slow in hepatic congestions, and all other symptoms obscurely marked; but if the slowness be supported by restlessness, sighing, thirst, wakefulness, &c., the danger is great.

A good pulse, excepting a moderate hardness, and incómpressibility, as sometimes happens in pneumonia, may be attended with grea

danger, which can only be inferred from other symptoms. Indeed, I may say in a universal sense, that the state of the pulse alone should rarely guide our conclusions, either as to the force of disease, or its treatment. The circulatory organs are so readily and variously disturbed by the nervous influence, and that influence so constantly generated by physical and moral causes, that disease offers but few opportunities when the pulse may be safely trusted for the just application of remedies without the support of other symptoms.

688, *k*. *Intermission*.—An intermitting pulse arises from an abrupt suspension of a pulsation of the heart. It is not an alarming symptom, unless it depend upon some organic affection of the heart, or some disease of the brain. It is a frequent attendant upon venous congestions of the liver, and often presents itself for the first time after the patient becomes convalescent, and may continue till the flesh and strength are restored. It is most apt to appear when the pulse is also preternaturally slow, and frequently vanishes temporarily if the circulation happen to be accelerated by transient causes, or a great irregularity of the pulse may be the temporary consequence. Its philosophy is explained in a foregoing section (§ 390, *b*).

688, *l*. *Irregularities* of pulse.—These consist of irregularities in its successive beats, redoublings, trembling, hobbling, &c., and are rarely of much importance unless proceeding, as in cases of intermission, from organic affections of the heart, or disease of the brain.

The Tongue.

689, *a*. We will now turn a brief attention to the morbid appearances of the tongue. It is by these, and the excreted products, that we obtain our most direct intelligence from the internal viscera, though other less sensible results may be more significant of the nature and force of disease.

689, *b*. The tongue is covered by a secreting membrane, whose action is liable to great and various changes, and which are attended by visible results. In its healthy state, this membrane is covered by a thin fluid, which is partly composed of its own mucous product, and, in part, of saliva. The natural color of the tongue is a light florid hue, and it is studded with short minute papillæ, particularly at its edges. In disease, these appearances are apt to undergo various changes; the tongue being often covered more or less extensively with a coat of variable hues, white, yellow, brown, or black, barely attached, or closely adherent, rough or smooth, &c. At other times, the organ is preternaturally red or livid, dry or moist, enlarged or contracted, pointed or obtuse, its natural coat thickened or apparently scraped off, or covered with patches, vermiform marks, &c., its edges jagged, the papillæ enlarged and elevated, &c. These conditions depend upon various modifications of the organic functions of the tongue; and as the organ is not much liable to independent disease, it is obvious that its morbid aspects are mostly sympathetic results; and from its being continuous with the alimentary canal and the lungs, morbific influences are readily propagated upon it from either of its remote connections (*i*). But, the vital relations of the tongue to the alimentary canal are far greater than to the lungs, though not strongly pronounced in health; and as intestinal derangements are more common than pulmonary, a far greater proportion of

the morbid and intense influences from these two sources are exerted by abdominal disease (§ 129 *i*, 135, 142).

689, *c*. The coating which forms upon the tongue may consist mostly of mucus, or of a substance resembling coagulable lymph, or intermixtures of both, in various proportions, and of a morbid character.

689, *d*. All the phases which the tongue is liable to undergo may be influenced by the peculiar constitution of the patient, though in a general sense, where the constitution is sound, these appearances are less subject to the contingencies of temperament than many other symptoms.

689, *e*. We often observe, under various circumstances of disease, that the coating has suddenly disappeared, and we may be led into error in consequence, since, in many of these cases, the coating has been removed by the mechanical friction of food.

689, *f*. It would be in vain to attempt a definition of the various changes in the aspect of the tongue which are produced by disease, according to its nature and seat, accidental causes, &c. The appearances may vary much under apparently the same conditions; and it is not one symptom alone which may attend the tongue, but the whole in combination, that must guide our judgment. Experience, therefore, is indispensable to enable us to appreciate the morbid states of the tongue in an advantageous manner; but as observation enlarges, and the depths of physiology are explored, we shall find the morbid signs of the tongue a luminous index of disease.

689, *g*. But, there is one remark more important than the rest; namely, that there are no other symptoms which borrow so much light from others, as those which relate to the tongue; while, in their turn, they reflect back a light upon the other symptoms. Inflammations of various parts, and idiopathic fevers, at their onset, may present nearly the same appearance of that organ, especially as it regards the coating. The general symptoms now contribute largely in determining the import of the tongue; though we shall generally find, on close inspection, that not only each class of diseases will offer certain peculiarities in the morbid aspects of the tongue, but as inflammation may affect one important organ or another; and the appearances will vary in the early stages of idiopathic fever, as the burden of disease may happen to be distributed. In the progress of the same affections, the tongue is continually fluctuating in the indications it may supply.

689, *h*. The disappearance of the coating in fevers and inflammations generally begins at the edges of the tongue, and is commonly indicative of an improvement of health, though not always. When these exceptions occur, some other morbid appearance is apt to follow immediately; as preternatural redness, or nakedness, or dryness, &c. If indicative of improvement, the tongue commonly clears up fast, along with other auspicious changes; though it will be frequently kept up, more or less, by remaining, though slight visceral derangements in the abdomen.

689, *i*. Absolute diseases of the digestive organs affect the tongue more variously and distinctly than other parts; according to their nature, seat, intensity, duration, peculiarities of constitution, habits, &c. (§ 129 *i*, 142). In indolent affections of the stomach, a thick, dirty, yellow coat, easily scraped off in part, appears particularly

toward the root of the tongue; when, also, the tongue often becomes furrowed, or covered with patches of various forms, indented at its edges, or apthæ arise; the coat, too, varying according to the varying states of the intestinal canal, or of the liver, &c.

689, *k*. If the tongue be very red, it denotes more or less active inflammation of some part of the intestinal mucous tissue; and if also dry, and especially if at the same time denuded, it shows inflammation of greater intensity in that membrane. A tongue preternaturally naked, even if moist, and of no great redness, shows moderate or sub-inflammation of the mucous tract; probably of the small intestine. A livid tongue shows venous congestion of the alimentary mucous membrane, and probably also of the liver. It is always indicative of formidable disease.

689, *l*. In connection with the foregoing subject I may advert to an inflammatory state of the mucous tissue of the fauces which ensues upon congestive affections of the chylopoietic viscera, and which is too often regarded as an independent disease, and treated accordingly. But, the condition of which I speak is so comparatively unimportant with the primary affection upon which it depends, and is so often significant of the force of obscure, but dangerous forms of abdominal congestion, especially of the liver and intestinal mucous tissue, that I would rather place it among the symptoms, than designate it, in its true character, as a sympathetic form of disease. This inflammatory affection is commonly of an erysipelatous nature, attended by more or less tumefaction of the tissue, and often of the tonsils. It varies greatly in intensity, and presents different hues, from bright scarlet to livid; the latter being the worst, and denoting a profound and dangerous modification of venous congestion (§ 813–816). In its worst forms, the throat is quite liable to ulceration, and often to sloughing. In the latter case it is commonly denominated the "putrid sore throat," and, most unhappily, this symptom, as it were, has been extensively regarded as the main disease. These appearances of the throat are also a common attendant on bad forms of scarlatina, and are due to profound congestion of the liver and intestinal mucous tissue, associated, more or less, with a peculiarly modified form of inflammation of the same tissue (§ 803, 816 *b*). The whole of this secondary evil is, abstractedly, of little comparative moment, and is analogous in its import to those forms of erysipelas which affect the surface when this symptom is epidemic (§ 463 *a*, 523, no. 7, 713, 970 *b*).

Secretions and Excretions.

690. The secreted and excreted products, which fall under the cognizance of the practitioner, are messengers of intelligence either directly from the citadel of disease, or from organs which participate sympathetically with affections of other parts, or which may scarcely do more than minister to the general wants of the body. They are, therefore, to be received according to their several degrees of importance. They consist of urine, sweat, mucus, and the alvine discharges.

691. *The Urine.*—No product is so variable as the urine, both in health and disease. The kidneys, being designed for great and immediate common purposes in the animal economy, in depurating the blood, or in transiently fulfilling the office of the skin, &c., are rendered highly sensitive to the presence of redundances in the blood, and

to the variable states of other parts, especially of the skin, whose analogous office is so liable to interruption. The same Great Intelligence, which ordained these final causes, also endowed the kidneys with a stability of function unknown to other parts (excepting the heart, for a like principle), where irritability is easily impressed. Being, therefore, but little subject to actual disease, the variable product of the kidneys commonly supplies only a report of the nature of the ingesta, or of the influences which the skin or other parts, and even the mind, may exert upon these organs in a healthy state, or of the mutable states of the body in regard to nutrition, or of morbid sympathetic influences, short of disease, which may be extended to the kidneys by diseases of other parts (§ 426). It is thence obvious, that but little dependence, in a general sense, can be placed upon the sensible changes of the urine as indicative of the nature or force of disease; and I have endeavored to show, here and elsewhere, that we may rarely trust to chemical analyses of this product (§ 417, 427). Beyond a transient inspection, occasional evaporation is about all that we require, unless, also, some practicable test in calculous affections. The aspects of the urine become more important in renal diseases, and in those of the bladder. Albuminous urine appears in organic affections of the kidneys, in dropsy, and after pastry and other indigestible food, and is produced by mercury and cantharides. It is evident, therefore, that the presence of albumen, about which so much has been written, indicates nothing specifically, unless supported by other symptoms (§ 421–427. Also, *Medical and Physiological Commentaries*, vol. i., p. 674–682).

A sensation like that of *strangury* is often felt when the urine is high-colored and scanty. This is commonly owing to abdominal disease; particularly hepatic congestion.

692, *a*. *Sweat.*—The perspirable matter is the least important of any of the tangible products of disease, unless as it respects the amount of sweat in its connection with the other attending symptoms, or as significant of the effects of certain remedial agents. Not much can be inferred from its quality, and this little is gathered from its taste and odor. Dryness of the skin is oftener an important character; and it is usually one of the best signs supplied by the skin when its dryness yields spontaneously. Perspiration induced by medicine is of little moment, unless the remedy simultaneously impresses, directly or indirectly, the parts diseased; and then the salutary results, so far as the surface is concerned, depend upon special vital influences exerted by the remedy upon the skin, and reacting sympathies. This is exemplified by the profound effects of tartarized antimony and ipecacuanha, the uselessness of hot water, and the frequent pernicious results of the compound powder of ipecacuanha, when free perspiration may follow the administration of either (§ 514, *h*). The effect, therefore, upon disease depends but very little upon the evacuation from the skin, as produced by what are called sudorifics; but upon the peculiar action which may determine the evacuation, and the consequent reflected sympathies from the organ. And this, by-the-way (for these opportunities may not be neglected), shows us the futility of the chemical hypothesis of the formation of the secretions.

692, *b*. Though sweating be generally a symptom of good omen, it may be one of the worst. Thus, a person suddenly falls down, in-

sensible, and copious perspiration ensues. It may be death from hemorrhage, or from a sudden cessation of the action of the heart, or it may be temporary syncope. Again, profuse perspiration often appears suddenly in protracted stages of disease. If the other symptoms are bad, the sweating is still more so. In these cases, the pulse is generally small and rapid. But it sometimes denotes the near extinction of life, when the pulse gives no sign of danger, and the sweating may be even considered favorable, if the whole circumstances of the case be not carefully weighed.—A viscid state of the perspiration is commonly significant of great force of disease. In some fatal cases of the cholera asphyxia there was only an insensible perspiration, throughout.

693. *Mucus.*—The mucous tissue being every where more or less exposed to irritating agents, is naturally protected by mucus, as the skin is by the cuticle; but only in quantity sufficient to cover the surface of the membrane. When, therefore, it is continuously discharged from the nose, expectorated from the lungs, or voided by the intestine, bladder, or uterus, it denotes a morbid state of the tissue; and that state is of an inflammatory nature. This is plain enough in respect to the nose, throat, lungs, and bladder; but the analogy is neglected in relation to the intestine, where it often supplies an important indication in the absence of other prominent signs of inflammation. This morbid organic product is liable to great varieties in its appearance and properties, each one of which depends upon a special modification of inflammatory action (§ 409 *h*, 410, 415, 682 *b*). Its exact condition will also conform to the natural modifications of the vital properties of that portion of the tissue which may be the seat of disease. Hence, in part, the varieties attending the morbid conditions of mucus, as it may proceed from the eye, nose, throat, lungs, and intestine (§ 133–135, 682 *b*).

Unlike the excrementitious products urine and sweat, the product of the mucous tissue, like all other organic compounds, is uniformly the same in health in the same parts of the tissue, nor is it liable, like the former, to undergo chemical changes as soon as secreted (§ 417). Its morbid changes are determined by the same precise laws as is its natural condition, and therefore each change depends upon some precise accidental modification of the vital properties and actions, and according to their natural modification in the part from which the discharge may proceed. Could we, therefore, always ascertain the precise character of its morbid changes, we should arrive as nearly as possible at the particular condition of the existing disease (§ 237, 682 *b*. Also, *Med. and Physiolog. Comm.*, vol. ii., p. 197, *note*).

694, *a*. *Alvine Discharges.*—The fæces consist of the superfluities of food, and the remains of various secreted products which are poured into the intestine from the liver, salivary and pancreatic glands, and mucous tissue. But, neither the bile, nor saliva, nor intestinal mucus, nor the gastric juice, appear in the fæces in their natural state. Combined, however, with the fæces, they offer a general natural standard for comparison with the morbid conditions.

694, *b*. In disease, the foregoing natural conditions as to quantity and quality of the secretions, and the state of the residual food, are more or less affected, according to the nature of the morbid states which may attend the various parts concerned in digestion. From the

number of organs, therefore, that are liable to be simultaneously involved in morbid processes, and which contribute their fluids to the alvine dejections, as well as the imperfect changes which the food undergoes in the stomach, it would seem more difficult than it is, in reality, to derive any just conclusions as to the nature of disease from the condition of the fæces.

The following are the most important signs to be noticed in the alvine discharges:

1st. *The Residual Food.*—This gives us intelligence as to the state of the stomach. It is mainly important in chronic affections of that organ, or during convalescence from acute disease; since, till the subsidence of acute diseases, the food should consist mostly of fluids, whether the stomach be the direct seat of the affection, or disturbed by sympathetic influences, or liable to irritation from solid food in the absence of those conditions (§ 512, 514 *h*, &c.). We may be thus guided, also, as to the food which should be avoided.

2d. The *nature and quality* of the matter discharged.—This, in acute diseases, will consist, principally, of the secreted fluids, which, so far as produced, may cease to be in any way appropriated, and accumulate in the intestine, though much, in respect to the apparent accumulation, may be due to the absence of residual food with which the secreted products are habitually intermixed. Their deficiency, during the operation of a cathartic, denotes severe disease in the organs of digestion, especially the glandular, or that an unsuitable cathartic has been applied. If the evacuation be large, watery, and colorless, the cathartic was bad. It has irritated, morbidly, the intestinal mucous tissue, has not reached the glandular function of the liver, or may have propagated injurious influences upon that organ. If a judicious cathartic have been employed, and not in excess, and mucus alone follow, it shows inflammation of the intestinal mucous tissue, and disordered action, probably congestion, of the liver (§ 693), which will be aggravated by a repetition of cathartics till the disease be lessened by other remedies; of which general bloodletting, leeching, and blistering, are the principal. Or delay of all remedies may be sufficient (§ 856, *a*). Again, a *redundancy* of bile may be either unfavorable or favorable, and its proper interpretation may depend upon a variety of considerations; such as color, the period, and past history, of the disease, the general and local vital signs, the nature of the remedies, especially of the cathartic, employed, &c.

When the bile is redundant, the mucus is apt to be at least natural in quantity, and when the latter is in excess the bile is commonly deficient, since, in the latter case, the formation of bile is diminished or arrested by injurious sympathies propagated upon the liver by the mucous tissue. It is the same as when morbidly-irritating cathartics diminish or stop the secretion of bile. And here I will say, that I am far from meaning alone what are denominated the drastic cathartics; since calomel, blue pill, and even the neutral salts, may be more morbific in a given state of disease than scammony, colocynth, aloes, and especially jalap, in doses of corresponding energy.

When the secreted products increase after having sustained a diminution, the sign is, perhaps, always favorable; but how far so will depend upon other symptoms, and upon the amount which is due to nature. In some hepatic congestions, cathartics procure but small

evacuations till the disease is considerably overcome. The secretions then start, become abundant, long continued, and a salutary bilious diarrhœa sometimes sets in. The same is also true of jaundice, whether arising from disease of the liver, or from obstruction by gall-stones.

3d. The appearance of the fecal matter as to *color*.—This is a very important index in many respects. We should distinguish carefully, however, what may be owing to color of food, or what may be imparted by medicine, from that which is morbid.

If the discharges be light, it shows a suspended secretion of bile, which may be owing to the irritation of an improper cathartic, or to inflammation of the intestinal mucous tissue, or to inflammation or congestion of the liver, or to jaundice, &c., and the other symptoms will clear up our knowledge upon the subject. In all these cases, as disease gives way, the bile is secreted in redundance, is apt, at first, to be blackish, or of a deep green, then changing to brown, or to a dark yellow, till it finally becomes of a lightish yellow.

Calomel and acids are very generally supposed to render the bile green. This they will do when mixed with the bile out of the body; but this chemical effect is counteracted by vital resistances afforded in the intestinal canal, just as putrefaction is arrested in food by the same agencies (§ 339, *b*). No quantity of calomel will impart a green color to the discharges of a healthy subject, nor will any acids; being an inquiry which I have sufficiently submitted to experiment. When, also, the bile becomes redundant and yellow during the decline of abdominal disease, neither calomel nor acids will affect its hue, unless a morbid irritation be produced. At the onset of disease there may be no green appearance of the dejections, till calomel or blue pill be given; but the reason is, that, till then, the secretion of bile was suspended, and what was accumulated in the gall-bladder is now dislodged. The mercurial agents excite the liver, and it pours out its morbid product; or, if they aggravate the existing hepatic derangement, the green may be increased by this vital influence of the agents.

It is important to do away with these misapprehensions; since they lead us to regard what is truly an important symptom of disease as the mere result of accident. The experiments, also, *out* of the body show us how fallacious are all such pursuits.

The worst appearance of the bile, *per se*, whether vomited or dejected, is a bluish color. It shows severe and obstinate congestion of the liver. Bloody mucus denotes more intense inflammation of the intestinal mucous tissue than a redundancy of simple mucus (§ 693). It shows dysentery, if attended with pain and tenesmus. Hemorrhage from the bowels or stomach denotes venous congestion and inflammation of the mucous tissue, in most cases; though now and then, in congestive fevers, the hemorrhage comes from the liver. In all the cases it is an effort of nature to relieve a very formidable condition of disease (§ 805. Also, *Med. and Phys. Comm.*, vol. i., p. 371–384; vol. ii., p. 546–566).

4th. Of the *sensations* produced by the fecal discharges on passing the anus.—These are mostly of a burning or excoriating nature, and denote either the presence of a morbid condition of the bile, or of acids that are generated by the decomposition of food. The suffer-

ing, however, generally arises from an acrimony of the bile. Aloes will, doubtless, produce irritation of the anus in some degree; but, when consequent on the use of that medicine, it arises mostly from the bile which aloes is particularly instrumental in eliciting from the liver; while its sympathetic irritation of that organ will also increase the morbid acridity of the bile. The fact is practically important, as will be readily seen from its bearing upon our conceptions of disease, and of the virtues of remedial agents.

694½. From what has been now said, it is evident that the dejections should be always examined in all diseases of any severity and obstinacy; and, if produced by a cathartic, they should be all examined, and each one in the order in which it may take place. This is the only way of practicing medicine intelligibly. The evacuations often supply more information as to the state of the abdominal viscera than all other symptoms. I say, therefore, when cathartics operate, it is often important to examine the dejections in the order in which they may take place. The first may consist only of the fæces resulting from food, and of secretions which had not assumed a morbid aspect. With this partial inquiry, as is often the case, we may conclude that all is right with the abdominal viscera, or that they are in a state to bear any violent remedies we may choose to exhibit for other purposes. But, on inspecting the second dejection, we may find it like chopped grass, or of a black, pitchy aspect. This brings us to the conclusion that mischief prevails at the citadel of life. What was evacuated at this second discharge was perhaps nearly the whole contents of the intestinal canal; and what may be evacuated at the third, or fourth, or farther dejections, will have been secreted after each successive evacuation.

If any salutary changes, then, be exerted by the continued operation of cathartics, we shall be likely to discover them in the color and other appearances of the discharges, as they come away one after another. If they remain without change, we may depend upon it that more work is to be done. But, on the other hand, if we find in the third evacuation that the green or the black has diminished, in the fourth it is paler, and the fifth has become yellow, we may be sure that art has greatly triumphed.

PATHOLOGICAL INDICATIONS FROM MORBID ANATOMY.

695. Lesions of organization, and all deviations from natural conditions which occur during life and are obvious to the senses after death, are embraced under the denomination of morbid anatomy.

696. All the foregoing results are owing to the pathological states which essentially constitute disease, and would not, therefore, ensue, could disease be removed soon after its invasion, or in its formative stage (§ 639, &c.). It is a great object of art to prevent their occurrence, or, as it is termed in the treatment of inflammation, to effect a resolution of disease.

697. Morbid anatomy has been pursued with various opinions as to its relative value to the vital signs of disease. Those who have regarded it of paramount importance have entertained but very limited views in physiology, or of the laws of disease. They have always considered the organ which was most frequently altered in its condition as the great primary seat of disease, and the cause of all the other lesions and phenomena, and even the cause of death. This doctrine, and its fallacies, I have considered very extensively in an Essay on the writings of Louis, and in another article devoted specifically to the inquiry; both of which appear in the *Medical and Physiological Commentaries.*

698. Morbid anatomy is indebted to Bichat for its rank in science, by whom it was cultivated in its most philosophical aspects. It was this great man who first employed it, extensively, in illustrating physiological and pathological problems; but more especially did he convert the living phenomena of disease to the uses of physiology.

The fruits which were thus gathered from morbid anatomy appeared to represent the field as a *terra incognita,* where great discoveries were to be made, and, therefore, great fame to be realized. The older pathologists were either unknown, or crowded aside; while the very ground which they had gone over was brought forward as newly-discovered land. The multitude lost sight of disease in its vital aspects, and undertook a system of pathology out of the last wrecks of disease; not unfrequently confounding the results of putrefaction with those of vital actions. Such was the general state of this branch of science, upon which, also, humoralism had again reared its venerable form, along with many other physical and chemical doctrines, when I undertook their systematic examination. Nor do I say this in a spirit of arrogance, but as simply due to the philosophy which I have endeavored to defend.

699, *a.* There has constantly been, however, a group of medical philosophers who have remained true to nature; and the profession, therefore, split into two classes, taking the names of the Hippocratic and the Necroscopic or Anatomical schools. The Hippocratists are observers of Nature in all her aspects; while the Necroscopists only contemplate her ruins.

699, *b.* The Hippocratists maintain that Nature is most significant of her existing conditions while those conditions actually exist, and

that we may better infer the nature of present causes by their immediate effects, than by the effects of other causes which may happen a week, or a month, or a year afterward.

699, *c*. The Necroscopic or Anatomical school maintain exactly the reverse of the foregoing. If, for example, a case of inflammation of the lungs occur, they allow no satisfactory conclusions as to the nature of the disease till the patient is dead, and it can be seen whether there be certain morbid changes of structure, or certain physical products, which they assume as necessary to constitute inflammation. "In this country," says the *British and Foreign Medical Review*, "few would be disposed to admit that inflammation had existed, unless some of its known products were brought forward as proofs." If, therefore, a patient die of inflammation in its formative stage, and before any of its peculiar products take place, it is contended that there was no inflammation, however violent and characteristic may have been the vital signs. Hence it is assumed that the cause of death, in cases of that nature, is wholly unknown (§ 748). It has no place among the "Vestiges of Creation" (§ 350¾, *h*). The *London Lancet* has a more proximate philosophy. Thus: "Inflammation CONSISTS in this, namely, that the *fibrin*, &c., which should pass *from the arterial into the lymphatic system*, [!] passes into the *venous*." "The true nature of inflammation lies in the above few words" (April 8, 1843).

A few of the most eminent of the Necroscopic school have exploded inflammation as a disease. This is extensively true of Louis, and universally so of Magendie and Andral; the last of whom affirms that "it is like an old worn-out coin, which ought to be discarded from circulation" (§ 753). Of fever, he says, "*The progress of science* has induced me not to devote, as in the former edition, a special volume to fevers."—"Singular '*progress*' that!" exclaims Cayol; "a few such steps, and medical science would be down at zero" (§ 740 *b*, 744). The distinguished Travers, in commenting upon the Anatomical school, especially its corruptions in France, remarks that, "out of the *debris* of the dead subject, however accurately inspected, examined, and arranged, to attempt a solution of the great problem of living actions, and to build upon such a foundation an edifice of pathology of self-support, is as injurious a fallacy, and scarcely less arrogant and absurd, than that of the Cartesian Philosophers, who undertook, out of the depth of their anatomical sagacity, to make a man."

699, *d*. Again, in another case where there may have been a succession of inflammations in different organs, and, although one or more in the series shall have entirely subsided, but the real cause of all that followed, it is assumed by the Necroscopic school that the last in the series had been the cause of all the phenomena from the beginning of the complaint. Such, indeed, as well as the preceding doctrines (§ 699, *c*), is the natural result of that large school of materialism which pretends to discover in the structure of organs, even in their molecules, the various conditions of life, and all its diversified phenomena (§ 131).

700, *a*. Take any case, in the wide range of diseases, and ere its termination, it may present many new problems for the pathologist. It may have lost its original character, or its variations may consist of such modifications of a common pathological cause, that the cure shall require alternations of opposite remedies. Every pathological change

is ascertained through the direct phenomena, and is a far more difficult effort than the primary conditions. Morbid anatomy contributes nothing through all the intermediate changes; and what, therefore, is its positive benefit in any given case of disease at its invasion or termination, if it supply us nothing throughout its progress? The whole matter is settled before morbid anatomy can yield its light; and Nature would have been untrue to herself had she left her dependence upon art to her own ruins.

700, *b*. The physical products of disease can, at best, only denote the nature of an antecedent functional action in which the essence of the disease consists, and which has more or less terminated in the particular part when the lesions of structure and morbid depositions have taken place (§ 732 *b*, 863). On the contrary, if disease consist in structural lesions, or other physical products, to what practical result does morbid anatomy conduct us, if it inculcate such a doctrine? Organic lesions, and often preternatural formations, are to the physician what they are to nature,—ulterior results; and they are equally unacceptable to both. If the positive symptoms of inflammation are to be set aside from want of some of its terminations, or even of vascularity, the foundation of practical medicine will be swept away, and clinical lectures should be confined to the dissecting-room (§ 730, 732 *b*).

701. Morbid anatomy, as taught by the materialist school, has precluded all regard for those pathological conditions upon which the lesions of structure and physical products truly depend, and about which the art of medicine is mainly interested. In its indiscriminate career, indeed, it cuts off all diseases except such as are known to the vitalist under the name of inflammation, and to which he refers those lesions of organic action and those new formations which alone engage the school of materialism. But the vitalist believes that "it is a rule of no small moment, in acute diseases," as expressed by Senac, "that there may be great disorder in the functions of the body without real inflammation, or any *fixed* disease in the solid parts. Yet these parts, which have experienced such deep and distressing affections, may, in a short time, be entirely relieved." "At the termination of a paroxysm of malignant fever, the terrible symptoms abate, and oftentimes disappear."

702. Morbid anatomy has not, in an original sense, ever given us a solitary clew to the pathology of disease, any more than healthy anatomy to the natural organic functions. We revert, at last, to the vital indications, or other immediate results, for this knowledge. The local symptoms are often an unerring guide, and those which spring from sympathetic influences, where morbid anatomy professes nothing, yield also their flood of light. We analyze the whole group of phenomena, and, by the aid of experience and principles, we go to the work of cure without a doubt or hesitation. There is no other mode of practicing medicine. Or, suppose the anatomist to attempt a therapeutical application of his own materialism, physiological and pathological; could he even *begin* to consider the condition of disease, or the nature of its treatment?

703. The legitimate objects of morbid anatomy are, to expound the sensible changes which may take place in the instruments of morbid action, the lesions of structure, and other new formations, which may

supervene upon disease. These it associates with what had been determined by the phenomena during life as to the essential pathological conditions; and, when doubtful cases may arise, from the absence of symptoms, should the physical results occur which have been found to be the regular sequelæ of certain known pathological states, it is then that morbid anatomy reflects its posthumous light with various degrees of importance. Yet certain it is that morbid anatomy can be of no advantage, so long as the symptoms, the true indices of disease, may be absent in any subsequent cases of the same nature, till the patient is again subjected to the scrutiny of the scalpel.

All physical results stand as the ultimate signs that a certain mode of action had existed, since these are the consequences of that action, of which the vital signs had been the attendants, and which had formed the sole ground of that pathological induction, which, after a series of observations, the physical products illustrate, and are taken merely as an indication that these vital signs, the basis of pathological inductions, had been present.

704. It is manifest, therefore, that the materialism inculcated by morbid anatomy destroys all rational attempts at pathological inductions during the treatment of disease; since, if the true import of the vital signs depend upon the ultimate contingency supposed, no just conclusions can be formed, either as to the nature of disease, or the mode of treatment, till the patient is dead. This, it will be allowed, is repugnant to reason; from which it will follow that the premises are wrong, and that true pathology reposes upon the vital emanations of disease (§ 756, *b*).

705, *a*. It is, then, upon the symptoms of disease, its remote causes, and the effects of remedies, that we are to depend in reaching all practical knowledge of any individual case, and, therefore, all cases of disease. But, since the physical products of disease, which are comprised under morbid anatomy, are the results of the same properties and actions upon which the vital phenomena depend, they form an ultimate and subordinate source of information; and since they concur, more or less, with the primary remote causes of disease in ultimately modifying the phenomena, it is important to know, as far as may be, the extent of their influence in this respect.

705, *b*. I may say, therefore, that the greatest practical use of morbid anatomy is the knowledge it supplies of the tendency of certain pathological conditions to result in the formation of physical products, or in disorganization; thus giving that direction and energy to practice that may be necessary to counteract the supervention of these deplorable consequences of disease. A second important practical advantage is the discrimination which morbid anatomy enables us to make between those phenomena which are the result of simple morbid conditions, and such as depend upon, or are modified by, the supervention of physical products.

706. Morbid anatomy can never alter the general principles which it may have assisted in forming. When, for example, the nature of common inflammation is ascertained in one part, principles are established which are applicable to this disease in all other parts, and at all times, and under all circumstances. The varieties must be ascertained by interrogating the particular phenomena in each individual case, and the treatment adapted accordingly. The great principles

will, of course, be always under the modifying influence of the phenomena from which they have been deduced, according as the principal phenomena may fluctuate.

707. When the structure of parts becomes deranged, or the properties of life are verging toward an extinction, we have totally a new order of things. Pathological principles are then upon the decline, and therapeutics is more or less afloat, and without compass, on the broad ocean of experiment. The organic being is fundamentally changed in his structure, and the laws by which he is naturally governed are more or less broken up. And I may also add, without intending to discourage its legitimate pursuit, that here it is that morbid anatomy begins, and has reared its pathological fabric on the ruins of organization.

708. Whenever morbid anatomy has been in the ascendant, the practice of medicine has been either experimental and empyrical, or has run into a mere system of "watching," or what was anciently denominated "a meditation upon death." We need only turn to the present state of medicine in the Capital of France for a melancholy exemplification of what I now state, and which I have set forth extensively in my Essay on the Writings of Louis.

709. The foregoing section leads me to a review of the past, and to inquire how far events have justified my former conclusions as to the superiority of American practice, and of American medical education, over European, as expressed in my Essay on the *Comparative Merits of the Hippocratic and Anatomical Schools.* I had deprecated more especially the corruptions of French medical philosophy, and was led to remark, that, "already our young men are crowding the schools of the French Metropolis in pursuit of a more thorough knowledge of morbid anatomy; and immuring themselves within the walls of Parisian hospitals, to contemplate the worst ravages of disease upon subjects of broken-down constitutions, and who have passed the ordeal of French hospital practice. They return home with Gallic pathology, and the *results* of Gallic therapeutics, which they could not realize in their own country, and will never witness again but by carrying out the principles which have supplied them with their means of information."

It is true that a few have been not a little employed in disseminating these corruptions in this stable land of sound medical philosophy; but, nevertheless, I am still able to repeat, that, "What Americans have received from the devotees of Morbid Anatomy, or from such as would make Chemistry the basis of organic science, has only tended to show them more distinctly, that the phenomena of life, in their various relations, are the true foundation of principles in medicine" (§ 350–350$\frac{3}{4}$, 744, 821, 830).

And now, having obtained the requisite permission from one venerable in years, profound in science, and long eminent as an expounder and teacher of medicine, and practically familiar with European habits, I shall here subjoin an extract from a letter which he did me the honor of addressing to myself, from Louisville, Ky., April 5th, 1846.* I am immediately prompted to this step by the

* In alluding to my DEFENSE OF THE MEDICAL PROFESSION OF THE UNITED STATES, Professor Caldwell goes on to remark that,

"On perhaps every part of your unsparing career throughout your task, from begin-

manner in which the Medical Profession of the United States has been lately presented to the World by the Medical Society of the State of New York, in the hope that I may be thus instrumental in

ning to end, my sentiments accompany you, and probably on *one*, at least, leave you a little in the rear. I allude to the *practical superiority* which the physicians of our own country hold, in general, over those of Europe, and I presume also, of course, of every other portion of the globe.

"Respecting the treatment of chronic complaints I forbear to speak; because my knowledge on that point is less full and thorough, and therefore my opinion less positive. But, in their rational, skillful, bold, and successful treatment of acute diseases, particularly of the classes *febres* and *phlegmasiæ*, the physicians of the United States are incomparably superior to any Europeans whose practice I have either witnessed in person, or read of in books. That this is true in relation to American complaints cannot be denied. Nor, in my opinion, is it less true in respect to those of transatlantic countries.

"Of all the physicians in Europe of whom I have any knowledge to be relied upon, I am most partial to the practice of certain Dublin gentlemen, and of those in some parts of Italy. In their treatment of disease they have often reminded me of *home*. And of all the practice I have ever witnessed, that of Paris is the most inefficient and miserable. Yet is it this Parisian school in which American pupils are most anxious and proud to be educated, and to which they are advised to repair; and most unwisely and inconsiderately advised. As far as *the practice of medicine* is concerned, if they do not there learn how *to kill* the sick themselves, they learn, or may learn, to perfection, the art of allowing their complaints to kill them. Never have I witnessed in Paris a single well-directed Herculean blow attempted in a case of fever. The battle was always fought in a Lilliputian manner. Nor, were I to say the same in relation to English and Scotch practice, would it be easy to refute the assertion. It is a well-known truth, that European physicians of every nation, who migrate to America, are, on their first removal, incompetent to the successful treatment of the complaints of the country; nor can any thing but experience render them competent to it.

"It is undeniable, that the physicians of Europe are, *in the mass*, very far from being an able and elevated body of men. Strike off the few, I might say the comparatively very few, who alone give lustre and standing to the profession, and the remaining 'million' will be found to be positively and strikingly the *reverse;* a very ordinary body, possessing not an element of distinction on the ground of either *talent* or *attainments*. And the same is true in relation to the pupils whom I have seen in attendance on the European schools. A majority of them, which may be called *vast*, are, in appearance, far inferior to the pupils of our own schools. Nor have I the least reason to believe them much, if any less, inferior in *mind* than they are in *person*. In proof of this, the American pupils, whom I have seen in attendance on foreign schools of medicine, were, in no ordinary degree, the finest young men belonging to the classes; the foremost, I mean, in every essential attribute of standing. Of this they were themselves confident and proud; and so was I.

"It is not true, then, that the *mass* of physicians in Europe are, in any respect, superior to the mass in the United States. In their treatment of disease, I fearlessly repeat that they are *decidedly inferior*. On each side of the Atlantic, the *west* not less than the *east*, there exist in the Faculty the *eminent few*, who, in talents and knowledge, are nearly on a par; the Americans, however, being at once the most efficient, most rational, and most successful practitioners.

"While I yield to no one, therefore, in the estimate I place on the *leading physicians* of Europe, I cannot admit that those of the United States are in any respect their inferiors. And I should deem myself unworthy my *birth-right*, were I not to discountenance the wordy tirade poured out so superabundantly in certain quarters, in disparagement of the education and standing of the great body of American physicians.

"For the inferiority of the mass of European physicians a plain and substantial reason may be assigned: they are enslaved by precedent and trammeled in mind, and are not, therefore, independent thinkers. And I need hardly add, where independence of thought is wanting, so are vigor and efficacy of thought."

"An overwhelming majority of the physicians of Europe reside and practice in country places, villages, and small towns. And, as already alleged, they are, *ab origine*, more or less of an inferior *caste*. Their education is also inferior. Hence, conscious of their inferiority, they look upward for light and direction, and *follow* those whom they acknowledge as their superiors. In this they but conform to the European *fashion*, according to which the lower orders of society do a sort of homage to the higher, and walk in their footsteps. So true is all this that there are few, if any, *medical commoners* in the Old World, who venture to think in any other way than *by authority* of some writer or teacher; whom they obey and adhere to as retainers do to their feudal lords. I need hardly subjoin, that in a condition so humiliating, it is impossible for physicians to rise to eminence.

"Much of this, however, you have yourself stated in your '*Defense of the Profession*,' or elsewhere. But I am not apprized of your having stated that the American youth can be *much better educated* in their own country than in any foreign one. Yet is the fact unquestionably true. I mean that it is a *fact*, and not a narrow-minded, selfish assertion. The real proximate elements of medicine are more thoroughly taught in some American

obliterating unmerited reproach, and in inspiring my medical countrymen with that consciousness of worth, and self-respect, and self-dependence, which they are so eminently entitled to enjoy.

schools, than in any European ones I have ever visited. This is especially true in relation to the *Principles or Philosophy* of medicine; without an acquaintance with which the practice of the profession is rank quackery."

I have no disposition to pursue the foregoing subject beyond what may seem expedient for the defensive purposes which common justice urges upon an injured right. The scope of remark is therefore designed to extend far beyond those domestic relations which might be adjusted without foreign aid. But our own self-reproach was not the offspring of conscious degradation. It was but the sequel of disdain which prospective greatness never fails to encounter on its triumphant march. The aspersions of the mother-country had been received in the dignity of silence, and they who undertook the game at home calculated to win through an imaginary acquiescence in foreign diplomacy and an accustomed non-resistance. All that was noble in our land had been the subject of unmitigated scorn; and so it progressed under the blandishments of diplomatic skill. I will not point, in testimony of this, to the "London Quarterly," or political, or other journals of inferior note; but that which has reigned supreme in the world of letters unfolds an amount of proof at which Honor and Humanity hang their heads in shame. The blows have not fallen upon the imbecile and weak. That is the coward's work, and would have yielded nothing to the final cause. A nation has been the intended victim, and therefore a nation's pride has been the target. The critique upon Channing in that National work, the *Edinburgh Review*, for April, 1839, is alone enough to dishonor any country, at any age.

I shall, therefore, briefly sustain the foregoing comparative estimate of the Medical Profession, in a limited application to "the Mother-Country." I complain not of any other; and revere the ancestor as a fading luminary, of the largest magnitude, whose resplendent light has only passed into other regions to advance the welfare of other worlds. I shall sustain the comparison, I say, by a quotation of one of many analogous comments that have lately appeared in a medical work which may be regarded as the oracle of the British Profession,—the LONDON LANCET.

In speaking of the existing state of medicine in Great Britain, and after representing British "works on pathology and the practice of medicine as deficient in originality and richness of materials," the veteran editor aims his Lancet at the very foundation. "Look," he says, "at the state of British pathology! Of what does the great majority of our books on this subject consist? Of compilations; of old views cooked up as new discoveries; of annotated translations; or, at best, of able and comprehensive digests of materials that were already before the public in other forms."—*London Lancet*, May 6, 1843. And may I not adduce, in support of the *Lancet*, what I have said in former sections of the reference and surrender of British medicine to the laboratory of a German chemist (§ 349, *d*, 376½, 676, 878)?

Shall Americans, therefore, go on to decry the efforts of their own medical scholars, degrade the whole profession of their own country, and sacrifice their own medical literature for what is conceded to be the present medical literature of Great Britain? It is not mine to complain of British critics for promulgating what could not be concealed; and, doubtless, it is the only remedy for professional apathy, the only stimulus to "medical reform," the only motive for "Parliamentary action," and the only means of extending education and of rescuing the practice of medicine from the hands of "*apothecaries*."

There has been no occasion for vindictive motive; which never fails to tarnish truth or polish error. The common ends of life are known to all, and each in his place, in the scale of conscience, weighs, to the weight of a thought, the right and the wrong. What was once true is true forever; and nothing has stood the test of truth like the great elements of national decline. In vain do we point to our former greatness, and call for help upon the past. The very power of example is gone. What was noble, was virtuous, was intellectual has passed to other regions, is cherished and honored in other climes. It is lost only to the land of its birth.

While, therefore, we adopt whatever is valuable from abroad, let us have a literature of our own, based upon American observation, American industry, and American genius. But, as I formerly said, let us remember the admonitions of history, that, when nations have begun to trample upon the past, to reject its experience, and to strike out new systems of observing Nature, it has been the most certain presage of approaching imbecility, and of that ultimate fall to which all are destined. When the great revolution shall have reached the Genius of Philosophy—"*το κρατιστον της φιλοσοφιας*"—the last vial of wrath is emptied, and that nation is irretrievably gone. This is humiliating to pride, and may have been designed as one of its correctives. But since *it is so* in the great plan of Providence, it must be sufficiently obvious, that, as a nation approaches its chaotic state, those who may be in the ascendant are bound neither to counteract the order of nature, nor to suffer their own prosperity to be blighted by the mildew. Ambition must follow the beaten path of philosophy. The denunciation of past experience is the ambition of egotism, which erects its innovations upon error, and imbues them with superstition and absurdities.

I say, therefore, let us have, at least, a *medical* literature of our own. There is nothing that will contribute like it to the nationality of Americans, nothing that will inspire so extensively the culture of other sciences, promote the advancement and refinement of the

Other, and perhaps I should say more important objects, are contemplated by this note, and which form no small part of the interests of medicine. They are the same which I have had uninterruptedly in view. They are those which are intended to designate the consequences of spurious systems. Those systems and their results must be displayed; and that, too, in connection with what may be designed as substitutes. Nor is there any inquiry in which this method is so indispensable as in the philosophy of medicine. Truth would never obtain, till the "lion shall lay down with the lamb," unless the Institutes of Organic Nature are presented in forcible contrast with the devices of art. It has been tried from the day when Hippocrates evolved the philosophy of medicine from Nature herself, and dragged it from the midst of error and superstition. It has been tried, I say, in vain. The present times bear me witness of the fact. The mind must enjoy ready means of comparison. Nay, more, the comparisons must be planned, matured, logical, and irresistible. Such, only, can give stability to medicine; can, only, illustrate and enforce the truth. I have made the attempt: I do but say a humble attempt. I design it as an example for more able pens; and ever consistent and firm in the views which I have now expressed, I would cheerfully become, upon my own method, the victim of a better philosophy. I would have corruptions, speculations of all kind, swept with an unsparing hand from the tablet of organic nature; and while, therefore, whatever I may have attempted shall remain unrefuted, uninvalidated, or however it may receive approval, or be condemned without "the ordinary prerogative of being presumed to be true until the contrary is clearly shown" (§ 376¾, *a*), I shall suffer the method of inquiry to remain undisturbed, the exposures of error to hold firm their places, in any future editions of this work; that they may unceasingly contribute to their original objects, and admonish the pretender, that some one more competent to the task may fasten upon him a universal verdict of guilt. They will therefore remain, as a safeguard to medicine, till the corruptions be shown to bear on their front the broad seal of Nature.

useful and ornamental arts, nothing that will so effectually confirm and carry forward that elevated rank which the Medical Profession of the United States have already won for themselves in the hearts of their countrymen. We have, indeed, already the foundation of such a literature in the multifarious writings of the hard-thinking men of America; and it is this very literature, and the general dissemination of knowledge in the American Medical Profession, their indomitable industry, their well-directed skill, and their discreet and dignified bearing, which give them higher rank, greater influence in society, than any other class. Look where we may, we shall be likely to find the medical man foremost in enterprise, turning night into day, leading in measures for the public health and for its general prosperity, curbing the impetuosity of error and superstition, rearing and consecrating temples to the Divinities of Health wherever a dozen worshipers can be found, and stretching out an influence which awakens all the elements of learning and industry. It is the Profession alone which is not true to itself.

In all that I have now said, I may not be suspected of undue partialities, for I am under no obligation to any portion of my profession in America, or of the American Republic; while I am actuated by the deepest sense of gratitude to some foreign countries that can be inspired in a man of literary habits. To those countries I am the more indebted as they are always just to my native land, do honor to her scholars, and are the great abodes of learning and philosophy. Nevertheless, in all the instances I have endeavored to speak according to my convictions of the truth, and the demands of my subjects; ever sacrificing self to those primary objects. If there may seem to have been asperity, I trust it will be found in the facts themselves, and in the unavoidable nature of the conclusions at which I have arrived.

INFLAMMATION AND FEVER.

710, *a.* I PROCEED to illustrate the most important principles in medicine, by considering those which are especially relative to *inflammation* and *fever;* the two orders of disease, indeed, which make up the great amount of human maladies, and form the great outlets of life. The few diseases which do not fall under one or the other of the foregoing denominations are least important in a practical sense, and least understood in their pathology. Nevertheless, a knowledge of the principles which apply to the pathology of inflammation and fever will greatly aid our interpretation of the essential changes which constitute the pathological conditions of other affections.

710, *b.* Inflammation and fever have been generally regarded as one disease, and they who have considered them distinct affections have offered no analysis by which their individuality may be established, and by which each complaint may be readily distinguished in practice. Important evils to the sick are therefore in constant progress from this source alone; and when there is added to it the entire darkness in which venous congestion has been shrouded, both in its absolute pathology and as it modifies fever and the recognized forms of inflammation, it may be safely said that a vast opening is here presented for the improvement of medical philosophy, and for the common welfare of man (§ 787).

INFLAMMATION.

711. I shall first state the outlines of inflammation, and its essential pathological characters; from which it will be seen that it takes its rise in purely physiological conditions, and holds its progress and decline under the same great natural laws of the constitution (§ 137, 149–152, 638).

712. Unlike idiopathic fever, which is a universal disease of the body, inflammation is always local (§ 143, 148). Fever, however, is often complicated with inflammation of one or more organs at or near its commencement, and the local disease may precede the constitutional one, and even become the *exciting*, though not the *predisposing*, cause of it (§ 645, 650, 651, 653). More frequently, however, inflammations spring up during the progress of idiopathic fever, and often attack and disorganize many important parts in rapid succession. Indeed, it is rare that fever exists long without this greater foe making its appearance, and adding seriously to the difficulties and dangers of the case (§ 779).

713. Owing to the foregoing complications, the capital mistake is often made of regarding the local affection as the essential or predisposing cause of the constitutional fever. Such pathologists assume, of course, that there is no distinction between fever and inflammation, and that both, therefore, are equally and always local diseases. But this is not the doctrine of those who depend less on morbid anatomy, and study Nature in her living aspects (§ 699). The single symptom which has given to fever its *name* has been a main cause of the confusion which prevails upon this subject (§ 589 *b*, 764, &c.).

714. Inflammations of much activity generally disturb, but very variously, the functions of many distant organs; but the sympathetic developments which spring up have mostly a different pathological condition from the primary disease, and such as are truly inflammatory are limited to a few parts; while all parts are affected in fever, and with pathological conditions more or less alike.

In chronic inflammations, sympathies are more slowly and less extensively produced, or not at all where more acute forms would occasion great constitutional disturbance; even when the brain or other important organs may be the seat of the chronic variety (§ 14 *o*).

Acute inflammation, on the other hand, is prone to give rise, at its early stage, to what is called *febrile action*, or *fever* (§ 134, 139, 140, 150). But this kind of "fever" is purely *sympathetic*, never precedes the local affection, and is mostly remarkable for a simple excitement of the heart and arteries; while in idiopathic fever, the most violent excitement often takes place without any appreciable antecedent local complaint, but simultaneously with the general excitement all the organs appear to have become involved in a morbid process; and now, also, inflammation may as suddenly supervene (§ 143 *b*, 148). The febrile condition proves an exciting cause of the other mode of disease, in some part predisposed to the inflammatory process (§ 674, *d*).

It appears, therefore, that great confusion has prevailed upon this all-important subject, and that causes have been mistaken for effects, and effects for causes. The excitement of the heart and arteries attendant on inflammation appears to have engrossed attention, inquiry to have stopped short as to all other organs, and a comparison to have been alone made between the general arterial excitement of inflammation and that which is attendant on fever. In one affection the general excitement may be almost the only element of disease beyond the local cause; in the other it is only one of a great number of elements distributed throughout the body (§ 487 *h*, 685, 686).

Again, it is fundamental with inflammation, that the sympathetic development of general arterial excitement will subside as soon as the local inflammation, or primary cause, is removed; but, in fever, the whole disease continues after the original cause is removed. The organs of circulation may be long subject to very high degrees of excitement, as often witnessed in the intermittent fever, without a shade of inflammation presenting itself during the progress of the disease. And how clear the characteristic distinction, that in intermittent fever the excitement not only disappears periodically, but according, also, to the type of the fever, while in inflammation it remains till the local cause is removed; when, also, the whole disease is at an end. But violent inflammations which coexist with intermittent fever may be entirely subdued, and yet the fever proceed uninterruptedly. Again, it is a common circumstance that all idiopathic fevers are introduced by a chill; while such is rarely the case with inflammations. The chill, too, and of great severity, may attend every paroxysm of a long-continued intermittent.

715. When inflammation gives rise to general arterial excitement, it is in part by continuous, and in part by remote sympathy (§ 498–500). The latter is mostly concerned in developing the general results. The nervous power being excited in the brain and spinal cord, is re

flected upon the heart and capillary blood-vessels of the whole system. That power, thus reflected, proves a stimulant to these organs, by which their action is increased, and otherwise modified (§ 188, 205, 226, 480–485). Again, the same primary inflammation which thus calls up a general excitement of the circulatory system, may be simultaneously producing inflammation of some other and distant part, through the same process of remote sympathy. That second part may have been predisposed to inflammation by some external remote cause, and the nervous power determined upon it may then operate only as an exciting cause. If the part be not antecedently predisposed, then the nervous power may prove the predisposing as well as exciting cause, or there may be other predisposing causes co-operating with it (§ 143–150, 226, 484 *b*, no. 6, 645, 652). This second part, thus sympathetically influenced, then becomes the source of other sympathetic influences; co-operating, in this way, with the primary inflammation, and increasing more and more the action of the heart and arteries at large, and developing inflammation in other parts, while, also, the general arterial excitement is a supplementary mechanical cause. The circles of sympathy now become very complex, and interwoven with each other (§ 148); and yet, through the same principle of remote sympathy, a blow may be simultaneously struck at the whole by one decisive impression from a single remedy. Bloodletting, for instance, will do it; but the operation of this remedy, although involving the agency of the nervous power, is different, in some respects, from that of any other agent. But, suppose it may be done by an active cathartic, combined with a nauseating dose of tartarized antimony. The pathological states of the various inflamed organs are every where nearly or considerably alike. A single remedy may, therefore, overthrow at once the whole complex condition of disease (§ 137 *d*, 143 *c*, *d*, 476½ *h*, 479, 481 *g*, 484 *b*, no. 5, 514, 557 *a*, 929–934, 944 *b*, 948).

What I have now said of the modus operandi of sympathy in relation to inflammation is applicable to the predisposing influences of the remote causes of fever (§ 148), of hydrophobia, of the constitutional effects of mercury, antimony, &c., and of all agents, indeed, which transmit their influences to parts remote from the direct seat of their operation (§ 500, 535, &c., 657).

716. The general sympathetic excitement is supposed to often constitute a state of *general inflammation*. But this is an error; since inflammation is always confined to some limited part, the minute vessels of which, and not the larger arteries and heart, are the instruments of the disease (§ 407 *b*, 410, 411). The term *inflammatory fever* is also objectionable, as being significant of what has no existence. The term *constitutional derangement* is commonly employed to denote the sympathetic disturbances which inflammation may inflict upon parts remote from its own location. It is the same condition that goes under the denomination of *fever* when owing to the sympathetic influences of inflammation. But, unlike idiopathic fever, *per se*, it embraces a variety of morbid conditions in different parts.

717. Inflammation occurring in one part may induce the same disease in another, and this last in a third, &c., independently of the foregoing affection of the heart and arteries. It often happens, also, that some sympathetic derangement will disturb the system far more ex-

tensively than the primary affection. The heart may be the only organ that may be disposed to sympathize with an inflammation of the skin; but, when the action of the former important organ becomes disturbed, though only its irritability be increased along with that of the general arterial system, it may develop sympathetically, and by a mechanical impulse of blood, extensive derangements, perhaps inflammations, in other parts. And so, in the same vital sense, of the stomach, brain, &c., when one of those organs may sympathize with some distant inflammation (§ 139, 140, 525 *c*).

718. The more active and extensive the inflammation, the more important the part affected, and the more irritable and disposed to sympathy the individual, the more readily, in a general sense, will constitutional effects ensue, and *vice versa* (§ 139, 140, 597 *d*, 600 *b*). Exceptions are seen in pleuritis and the mucous tissue of the fauces. But only, in the latter case, under special circumstances; probably of primary abdominal disease, when the secondary affection, which is commonly erysipelatous, reacts, in its turn, sympathetically (§ 589, *b*). The special sympathies of tissues and compound organs have been already considered in a general sense (§ 525–529). As it respects inflammation, a predominance is seen among certain organs, as the skin and mucous tissue of the alimentary canal. But the principle is more readily comprehended by observing its operation among parts whose natural physiological connections are strongly pronounced, as in the principal organs subservient to the process of digestion (§ 129, *i*). The sympathetic results may not be inflammatory, or of the same nature as the primary disease; but the organs which thus cooperate in a special function are readily disturbed when any one part of the system is invaded by disease, and as readily institute reacting sympathies among each other, and throughout the body (§ 514 *h*, &c.). The general constitutional affection is, therefore, often more or less dependent on the habitual association of the action of different organs while in health, as well as upon the nature of their vital constitution and their special relations to other parts of the body (§ 129). Owing, also, to the special modifications of the vital states of associated organs, some of them sympathize more readily than others with each other, and extend their influences more readily and powerfully abroad (§ 133, &c.). Thus, the small intestine occasions sympathies more readily and forcibly than the large, and the stomach more readily than the liver, with each other. But these morbid sympathies are not mutual among the parts where they occur most readily, and the same is true of their natural sympathies. Thus, inflammation, or any affection, of the small intestine commonly produces more or less derangement of the stomach; but the same affection happening to the stomach will not equally disturb the small intestine. Gastric disease readily deranges the liver; but hepatic affections do not as readily affect the stomach.

It may be also well to remark, that were it not that one part naturally sympathizes with others, it would never sympathize with them under circumstances of disease; no more than in plants (§ 447–461½).

719. Violent sympathetic disturbances which are especially relative to the nervous system often spring up from simple irritation of the nerves of a comparatively unimportant part, as convulsions from

teething, &c. These conditions have been confounded with absolute inflammation of the nerves (§ 526, *d*).

720. Having now endeavored to define the outlines which distinguish fever and inflammation from each other, and indicated, at the same time, some of the important general attributes of inflammation, I shall proceed to examine the more direct characteristics of this Protean disease; when, also, other and more radical contradistinctions from the pathology of fever will necessarily arise.

721, *a*. Inflammation is a very comprehensive genus; or, perhaps, it should be rather said, it is a species of disease which embraces a multitude of varieties.

721, *b*. According to the varieties, it is divided into *common* and *specific*.

In its most simple form, as arising from mechanical injuries, or as manifested in pneumonia, pleurisy, catarrh, &c., it is distinguished as *common* inflammation (§ 652, *c*).

When the disease presents certain peculiarities that are not attendant on the common form, it is called *specific;* as in small-pox, scrofula, lues, gout, rheumatism, &c., and in all cases of animal and vegetable poisons (§ 650).

722, *a*. Between the foregoing characteristic examples of common and specific inflammation, there is a vast range of gradations, which meet, as it were, together; so that it is evident no definite line exists, and that all the individuals belong to a common family. The very extremes are so much alike, that they may be compared to twins, which we may mistake, one for the other, at a superficial glance, or may only know them apart by some peculiarities of mind or manner; but which peculiarities, again, have so many points of resemblance that the same general system of moral and physical discipline is adapted to each of the twins, with only some special modifications to suit the peculiarities of each.

722, *b*. In a general sense, when inflammation is produced by a single cause, it appears under the same modification or variety (§ 652). But when two or more predisposing causes concur in establishing the morbid change, the modification thus induced will be determined more or less according to their combined virtues (§ 652). Thus, cold applied to the surface generally produces what is called common inflammation. But it will also act as a predisposing cause of acute rheumatism, which is a specific form of inflammation, and therefore possesses peculiarities which distinguish it from all other forms. Hence, in this affection other predisposing causes are concerned, the principal of which may be ingrafted upon the constitution, or if transitory, may have begun the foundation of disease in the organs of digestion (§ 659, 661).

722, *c*. Inflammation is also modified by the natural peculiarities of the vital properties in the different tissues, and the sympathetic influences it may exert will often depend, both as to kind and intensity, upon the nature of the tissue inflamed, and the general nature of the compound organ of which the tissue may form a component part. As to the modifications of the disease and the sympathetic influences as affected by the nature of the tissue, good examples of difference occur in the comparative phenomena and sympathetic effects of pleurisy and phlebitis (§ 150, 160–162, 807, 809, &c.).

As to the modifications of common or specific inflammation which grow out of the combined peculiarities of the vital properties of particular tissues and of the compound organ of which the inflamed tissue is a component part, we have numerous and striking examples; as in inflammations of the brain, stomach, liver, intestines, &c.

Again, the phenomena will be varied as inflammation may affect different parts of one and the same continuous tissue, according to the nature of the compound organs into which the different parts may enter. Examples of this occur in the pulmonary and intestinal mucous tissue, wherever it contributes to variations of the general structure (§ 135–140).

722, *d*. From all that has been now said, it is evident that those lesions which have been rejected from the general denomination of inflammation by Louis, Andral, Marshall Hall, &c., and arranged under the designations of hyperæmia, hypertrophy, lesions of nutrition, irritation from loss of blood, contra-inflammatory action, &c., but attended by many of the characteristic marks of inflammation, fall naturally within the range of this variable affection, (§ 725. Also, *Med. and Phys. Comm.*, vol. ii., p. 317–331, 712–715, 760, &c.).

723, *a*. Inflammation is also divided into *acute* or *active* and *chronic;* the former being more violent than the latter, comparatively of short duration, and commonly distinguished by a greater variety of local results, and far greater constitutional derangements.

723, *b*. The foregoing pathological states, being essentially alike, run into each other; so much so, indeed, that what has been chronic may suddenly become acute, and pass with great rapidity through the different stages. There is, therefore, no other foundation for this division than such as is here indicated.

724. I am now conducted to an analysis of this disease, and shall consider it,

1. In its most simple condition, as affecting different tissues.
2. As affecting different parts of different structures.
3. The varieties of inflammation in respect to its general attributes.
4. The sympathies to which it may give rise.
5. The remote and pathological causes of inflammation.

The first four problems will be considered connectedly.

725, *a*. In a general sense, inflammation is attended by *redness, tumor, heat,* and *pain.* They were once supposed to be essential phenomena; but either may be absent, particularly exalted heat and pain. Their presence or absence, intensity or mildness, may depend upon the nature of the morbific cause, the nature of the tissue, &c. (§ 651, 722). Thus, there is no redness from the bite of a musketoe, and there is intense itching instead of the exquisite pain occasioned by the sting of a bee. None will deny that the affection resulting from the latter cause is exquisitely inflammatory, and all must allow the near coincidence between the two affections. By this analogy we bring, also, the white nettle rash, the white gangrene, scirrous tumors, &c., under one general pathological condition (§ 722, *d*).

725, *b*. Again, for example, in respect to pain, much will depend upon the nature of the tissue affected, and upon the force and kind of inflammation. Inflammation of the serous membranes is attended with far greater pain than the mucous; in which last it is often absent. Simple pneumonia may exist to an alarming extent with little

or no pain. The serous tissue, also, possesses only colorless blood-vessels in its healthy state, but is apt to become more florid in its inflammations than the mucous. On the other hand, parts which have only a dormant state of sensibility, as the tendons, bones, ligaments, may become exquisitely painful when inflamed, and more so when inflammation is produced in the fibrous tissues by a lacerated than an incised wound. But the reverse of this last is true of the skin (§ 652, *c*). It is also worth observing, as contributing to a knowledge of the properties and laws of life, that while *common* sensibility is liable to be exalted in inflammations, *specific* sensibility, as seeing, tasting, feeling, is apt to be diminished, or impaired in a different way from common sensibility (§ 133–137, 193–204).

725, *c*. It would appear, therefore, that increase of sensibility is only a contingent result of inflammation. This property, too, is not directly concerned in the organic functions; and a part is quite liable to become inflamed when all its principal nervous connections with the brain and spinal cord are separated (§ 188, 193, 205, 489, 500 *d*, 746 *c*, *d*).

726. There is generally more or less pulsation in the inflamed part, and in the larger arteries leading to it (§ 498, 516 *d*, 803). In all such cases the extreme capillary arteries, which are the immediate instruments of the disease, and which naturally carry only white blood, have become enlarged, and admit the red globules. This transmission, however, of the red globules is not due to the enlargement, but to a change in the relation of the vital properties of the vessels to these globules (§ 192, 384, 394, 396, 398, 399).

728. Like the arteries, the veins of an inflamed part are increased in size; at least when the former are enlarged. This is owing to active dilatation of the veins, and to the increased volume of blood transmitted to them (§ 387, 786, &c.).

729, *a*. Common inflammation, when it goes on to a natural termination, and in its greatest latitude of simple results, may be distinguished into four stages; namely, the *formative*, *suppurative*, *ulcerative*, and *restorative*, or *granulating*. There may be present, therefore, from what has already been said, only the formative stage (§ 700, &c.). When the disease does not advance beyond that stage, it is said to terminate by *resolution*. The suppurative and restorative stages form the most simple natural process of cure. They are also subject to great irregularities.

Pathologists have generally reckoned the *adhesive* process as a distinct stage of inflammation. It will be seen, however, that it is not founded on principle.

729, *b*. The curative stages of inflammation, whether regular or irregular, are also called *terminations* of inflammation. The term is significant of what has not truly happened; and, as words have often more force than facts, it should be abolished. There is great practical philosophy concerned about the mutations of disease at the several regular stages of inflammation, and in all the modifications to which those stages are liable. There is but one termination of disease, excepting death. Disease remains, however altered from the formative stage of inflammation, till nature is completely restored (§ 672, 733 *c*).

730. The *formative* stage is distinguished more or less by the characteristics already described.

The *suppurative* stage is introduced by a decline of all the symptoms of the formative stage, and when most regular there is a production of purulent matter, which constantly tends to a more complete removal of the formative stage.

The *ulcerative* stage is more or less attendant on the suppurative; always accompanies the formation of pus excepting on exposed surfaces, when it may be present or absent (§ 733, *b*). Whenever present, it is immediately antecedent to the restorative or granulating stage, although a destructive process.

The *restorative* or *granulating* stage is promoted by the suppurative, and is marked by a continued decline, and ultimate disappearance of all the symptoms.

731. The foregoing stages are generally more distinctly marked in the cellular than in other tissues. With the exception of the ulcerative, they may be often well observed upon the mucous tissue of the eye. The ulcerative is seen in the intestinal mucous membrane.

732, *a*. Deviations occur in the suppurative stage in the production of coagulable lymph, or of serum, or redundant mucus, or effusions of blood, instead of purulent matter. But these results, or however they may deviate from their proper standard, are all analogous to the formation of pus, being exactly equivalent in principle, constitute equally the second stage, and, in the same way, contribute to the restorative stage, or that of perfect cure (§ 732 *f*, 740 *b*, 764 *e*, 863 *a*).

732, *b*. The fluids effused operate as depleting means; and it is especially for this reason that morbid anatomists, not finding the vascularity they had anticipated, declare that its absence in many dropsical affections denotes an exactly opposite pathology from that where the *same* affections are attended by a preternatural fullness of the vessels (§ 699 *c*, 700 *b*). Nature, however, has no such inconsistencies (*Med. and Phys. Comm.*, vol. i., p. 180–182; vol. ii., p. 187, 199, 556, 557, *note*). At the first reference here made, I have quoted the *mechanical rationale* as propounded by Andral, and have endeavored to prove, by his own showing, that what are denominated "passive dropsies" depend on a vital, inflammatory action (§ 740 *b*, 805, 863 *a*).

732, *c*. When the second stage of inflammation is attended by an effusion of coagulable lymph, it is called the *adhesive*, instead of the suppurative stage. This variety appears mostly in the serous and cellular tissues, though it is often presented by particular parts of the mucous system, as that of the trachea, in croup, and of the intestines (§ 133–135).

732, *d*. When wounds heal from the effusion of coagulable lymph, it is by the "first intention;" though the process is the same as when the pleuræ unite, or the lungs become hepatized in pneumonia. In either case, the formation of lymph is a part of the natural process of cure (§ 732 *a*, *b*, 863 *a*). However momentous the evil in pneumonia, or other disorganizations, it is still the result of the great recuperative law; just as effusions of blood within the head in cases of cerebral congestion are on a par with hæmoptysis, hæmatamesis, &c., or all dropsical effusions with each other, and with the preceding results. Nature does not step aside from great principles for minor purposes. But, in the apparent contradictions now stated, Nature has duly provided for the removal of extraneous matter from shut cavities, and from the recesses of organization by the function of ab-

sorption (*Med. and Phys. Comm.*, vol. i., p. 371–384; vol. ii., p. 546–566, 733).

732, *e.* It is also a peculiarity of lymph not appertaining to pus, that it is readily susceptible of organization, whereby Nature accomplishes other purposes; though such organization occurring in pneumonia is, as in § 732, *d*, an apparent though not a real departure from the great law of recuperation. Being a law of Nature for reparation in other parts, it must, under equal circumstances, prevail in all parts.

732, *f.* It appears, therefore, that the *adhesive* process consists of two stages; that by which lymph is effused, and the strictly adhesive. And, although the effusion of lymph be equivalent to the suppurative process, there is superadded to the former a distinct final cause, since Nature contemplates in this modification not only the curative effect, but, also, the reparation of injured parts (§ 732, *d*).

733, *a.* When suppuration occurs upon surfaces, as on the mucous tissue, the process happens in its most simple form. But, in other instances, as when pus is generated by the cellular or serous tissue, the matter cannot escape as when it is produced by the mucous tissue. In these cases, therefore, an obstacle intervenes between Nature and the cure, as when the formation of lymph or of serum takes the place of purulent matter (§ 732, *d*). But here, as there, Nature has provided for the removal of the secondary evil, through a principle common to all the cases, and which appertains to the absorbent vessels. This happens after the following manner, which must be briefly stated as characterizing an important law, and the third stage of inflammation.

733, *b.* The process is called *ulceration* (§ 730). It consists in the absorption of all the tissues intervening between the accumulated matter and some external surface. It is so significant of a great final cause, so replete with evidences of Design, especially in connection with the other attendant processes, that some authors, even Hunter, have metaphorically ascribed it to something like intelligence. It is to be observed, also, that in this complex condition there is in simultaneous progress both the formation of pus and of lymph. The pus occupies the central parts of the abscess, while the lymph is effused at the circumference, agglutinates the cellular tissue, and thus, by forming a sac, prevents the spread of the purulent matter. It is yet another part of the complex law under consideration, that while the substance between the abscess and external surface is constantly yielding to the ulcerative process, *reparation* or the *granulating* process is going on posteriorly to the abscess, and the redundant lymph undergoing absorption, or what is equivalent to the ulcerative process in the anterior part of the abscess. There is, however, a certain difference between the processes; but it is less than between the absorption of lymph in the present example and the function which is in universal operation in health. In the case before us, like ulceration, the absorption of lymph is an emanation from inflammation, though more remote than ulceration. Both, therefore, may be regarded, though not equally, as pathological conditions of absorption (§ 672).

733, *c.* When the surface is reached, and the matter discharged, the cavity is no longer circumscribed. Nature now puts an end to the destructive process, and completes the work of reparation which had been in progress in the posterior part of the abscess. This is ac-

complished by the formation of a substance analogous to that which had been removed. Coagulable lymph, along with more or less purulent matter, is secreted by the surface of the ulcer, upon which it is arranged in little fleshy heaps, or knobs, of a florid color, and forms the granulations. These knobs contract and spring from the top of each other till the cavity is filled.

Among the various and striking results which are involved in this process of reparation, none is more remarkable, or more strongly exemplifies its dependence on laws that are unknown in the inorganic world, than one which is least appreciated, the substitution for the granulations of an organized substance similar to that which had been removed. The granulations have, originally, the same apparent physical characteristics, from whatever part of the body they may spring. But they are so endowed with the special vital characteristics of the parts by which they are generated, that in each part they secrete a substance which is similar to the part removed, while the granulations themselves are progressively absorbed (§ 135, *b*). Doubtless, also, the granulations are specifically different, in a physical sense, in all the cases, differently organized, and therefore, as in all other cases of organized lymph, derive their vessels from the parts by which they are generated (*Med. and Physiolog. Comm.*, vol. ii., p. 354–362).

The cavity being filled, the granulating process ceases, as if instinctively, and a new one sets in, by which the granulations are covered with a substance analogous to skin, and which is called the *cicatrix*. This completes the series of Designs attendant on the different stages of an abscess, and which exemplifies all the regular stages of inflammation (§ 729, *b*).

733, *d*. Who shall resolve the foregoing wonderful processes and results, their exact concurrence, their united object for one great final cause, by any process or laws of the inorganic world? Yet is even this now almost universally attempted! Such is ever materialism! But, when it will not listen to the voice of Nature as it proclaims her Author, we may hope in vain for any interpretation of her phenomena that may recognize dignity or design in her minor aspects, and least of all as it may conflict with the fundamental principle of materialism. When error is bold in its demonstrations, it is studious of consistency, and therefore regardless of facts (§ 5¼, 5½, 40, 80, 117, 137, 143, 155, 156, 169 *f*, 172 *b*, 226, 303¼ *a*, 306, 310, 311, 350¾ *g–o*, 376½, 384, 385, 387, 399, 409 *f*, 422, 500 *n*, 514 *h*, 524 *d*, 525, 526 *d*, 528 *c*, 638, 649 *d*, 733 *b*, 764 *b*, 811, 847 *c*, 848, 902 *f*, 905, 943 *c*, 980, 1019 *f*).

733, *e*. As we have now and before seen, Nature often contemplates a variety of useful purposes in the individual processes she adopts for the benefit of organic beings. The healthy state of the body is full of examples. Every action of every part has commonly more than one definite object; often many. So is it, also, with those morbid processes which are instituted for the restoration of health. As soon as the tendency in diseased actions is set up toward the natural condition, the subsequent changes have a specific reference to the ultimate cure; the completion of which, however, may be very remote from the initiatory step. The vital properties and actions may pass through a variety of changes before they attain the natural physiological condition (§ 672, 676). But each change, each step in the

process, may be necessary to the next succeeding, till Nature attains her normal condition. This, however, is only one part of Nature's plan in her salutary efforts to escape from disease. She renders various results, as she goes along, instrumental in bringing about the subsequent steps in the process of cure, and even associates with these other useful objects. In the case but just before us, while ulceration is making its way to the surface for the discharge of matter, the purulent formation is constantly subduing the inflammation, and the secretion of lymph, which is designed for agglutination and granulation, has the same salutary influence upon the morbid process on which its production depends (§ 764, *e*).

The properties of life are thus constituted in such a manner as not only enables them to undergo changes from their diseased to healthy states, but, through their instruments of action, to result in the formation of products which shall contribute to this great ultimate end (§ 672, 733 *d*, 761).

733, *f*. The foregoing law of *reparation* prevails universally in organic beings; extending, therefore, to the vegetable kingdom. It appears, however, under various modifications, even among the animal tribes. It is presented in its most simple form in the growth of divided polypi, the reproduction of the claws of lobsters, of the lizard's tail, &c., when it takes the name of *regeneration*. But, it is equally an act of regeneration when ulcerated parts are restored in their former organization by the granulating process. The difference consists alone in partial modifications of a common action (§ 733, *b*). In the regenerative and reparative processes of plants the difference is still greater; and such as reject analogy, or cannot discern its light, have argued that the differences depend upon essentially different laws. A previous inflammatory action, it is true, is necessary to reparation in the higher order of animals, but is not necessary to the fundamental law as it is concerned in the regeneration of entire parts in the lower animals, nor in the reparative process of plants. The properties of life are differently modified in each, and consequently the processes differ, though as intimately connected by analogies as the modifications of the simple physiological states (§ 185, 672, 688 *ee*, 733 *e*). Nor is the granulating process an inflammatory one, but only consequent on that pathological condition; while the simple production of lymph may be a direct emanation from inflammation, or only consequent on its decline, or on a near approximation to that mode of action. All the modifications, however, give rise to corresponding varieties in the nature of the lymph, just as they do in that of purulent matter. They may offer to our inadequate vision the sameness of appearance that is presented by the pus of an abscess, or of a chancre, or of small-pox, or appear as identical as the granulations of every part. The last, indeed, are the things in question; and although their ultimate results supply an unerring test, it is only coincident with all the others, and even with that which is offered by the natural states of the different tissues (§ 22, 42, 48, 53 *b*, 133, 135 *a*, 409 *e*, 411, 739, 740).

By thus pursuing the inquiry, the various results will be found connected by close analogies, though the extremes may be stumbling-blocks to the careless. The periodical regeneration of the stag's horn, where some of the most characteristic marks of inflammation

are present, forms an intermediate example. But the deer, in other respects, is as limited as man, or other animals of the same complex organization, as to the principle of reparation. In all such animals, the amputation of a limb, or the removal of any important organ, is never followed by a regeneration of the part. Such parts do not embrace, like the parts of a polypus, or of a plant, the organization that is necessary to constitute a whole. Nevertheless, the law obtains, even here, to a remarkable extent. If the middle of a bone be removed, it is regenerated. But there must be opposite surfaces, and the right action must be instituted in each surface, as when the opposite pleuræ unite. In the same way central portions of the muscles and nerves may be removed and regenerated; and the process by which this is accomplished is the *granulating*.

733, *g*. This leads me to notice a fallacy of the physical philosophers, who have been led into the error, as in most other cases, from neglecting, if not altogether the vital properties, at least their natural modifications as they exist in vegetables, and in the different races of animals (§ 133–163, 185). With this neglect of fundamental principles, and a substitution of chemical and physical laws (§ 5¼, *b*), they have endeavored to array an argument against the Hunterian doctrine of the dependence of the union of wounds, by the *first intention*, upon inflammatory action, by identifying the process of reparation in vegetables with the union of incised wounds. Reparation in plants, say they, is not an inflammatory process, and, therefore, the effusion of lymph in the incised wounds of animals is not connected with inflammatory action; and they endeavor to fortify this reasoning by an appeal to the regenerating power of the polypus, the lobster, &c. As well might we argue that vegetables, and polypi, should be subject to the same diseases as man or quadrupeds, or that all animals should live alike upon the same kinds of food (*Med. and Physiolog. Comm.*, vol. i., p. 696–698).

733, *h*. The same objectors, however, set aside, on other occasions, some of the plainest and most important analogies of nature. They maintain, for example, that the functions of nutrition, secretion, &c., are carried on in all animals mostly through the nervous system, but are compelled to take a very different ground for the same functions in plants (§ 350, no. 18–20, 62, 63, &c.).

The nervous system, however, being superadded to animals, modifies greatly their common properties and functions of life, expounds, in part, the differences and special analogies in the foregoing processes of *reparation*, *regeneration*, &c.; and being a superaddition to animals, and a large, however unintelligible element in the doctrines of the physical philosophers of life, I formerly employed it as the ground of an analogical argument that the principle of life was originally superadded to animals after the creation of their structure.

733, *i*. Consider, also, the parallel which holds between the morbid growths that are induced by special injuries of the animal and vegetable organization. Take an example of the latter in the nest of the Cynips quercus folii; and how evident is it, from this simple fact alone, that both departments of the organic kingdom are endowed with the same organic properties and functions, alike liable to disease, and governed by analogous laws (§ 185, 191 *a*, 409).

All the foregoing may be farther illustrated by what I have said in

a former section of inflammation in its connection with child-bed women, &c. (§ 688, *ee*).

733, *k*. It is certainly remarkable that such obvious analogies should strike different minds under such different aspects, and doubtless many will think it superfluous that misapprehensions of the foregoing nature should receive a formal refutation. But they are sustained by minds that have a powerful influence, and must be respected. It is so, indeed, with the delusions of imagination itself; and were not a certain degree of resistance opposed to animal magnetism, its votaries would trespass far upon the domain of physiology, and trample without remorse upon universal knowledge.

Irregularities of Inflammation.

734. The regular stages and results of common inflammation which have been now described are subject to various irregularities, which spring from innumerable causes, but especially from morbific influences propagated from the organs of digestion. A great variety of modifications are also attendant on the specific forms of the disease; when the special results are apt to be mostly due to the nature of the predisposing cause. At other times, and in numerous cases of common inflammation, certain effusions, such as coagulable lymph and serum, which are equivalent in principle to the suppurative stage, appear to be regular stages. But they so often run into each other, that it is more philosophical to regard suppuration as the elementary process.

735, *a*. Instead of the progressive stages of inflammation, the disease may terminate in *resolution*. This result is generally intended to embrace one of the common products, coagulable lymph; the name and mode of termination coming to us from the humoral pathology. But, according to the philosophy which I have endeavored to set forth, I reject both the "concoction of humors" and the effusion of lymph, and mean by the term *resolution* a simple restoration of the morbid properties and functions of an inflamed part to their natural state, without any other supervening result beyond the *formative* stage (§ 729, *b*).

It is a primary object of art to anticipate nature in her depletive course, and thus prevent inflammation from passing beyond its incipient stage. It is here that the advantages of art are strikingly illustrated; since unaided nature proceeds to the cure by effusions of lymph, pus, serum, &c. (§ 732 *d*, 863).

735, *b*. Inflammation frequently advances in its formative stage without being circumscribed either by effusions of lymph, or by other causes, and it is then *diffuse*. This irregularity is apt to attend upon some tissues more than others, especially the venous, lymphatic, cutaneous, and serous. There are also certain striking facts relative to diffuse inflammation which go to illustrate important physiological laws. Thus, in erysipelas, it is apt to be symmetrical upon both sides of the face. In phlebitis, the inflammation is often limited to the divergence of a vein (§ 741, *c*). In small-pox and kine-pox, the inflammation extends only a certain distance around the pustules, though not limited by the adhesive process. And here we may notice one of the various demonstrations of a law expressed in § 149, in the manner in which the sinapis, cochlearia, rhus vernix, &c., produce *diffuse* in-

flammation of the skin (§ 649, *c*). Each of all the cases, and thousands of parallel examples, each as a whole, or in its details, supply so many problems for the profound inquirer, reveal the apparent mysteries of life, and stamp their seal upon the doctrines I have taught (§ 133–163, 177–184, 188–192, 651–657, &c.).

736, *a*. Opposed to the termination of inflammation in resolution is that of *mortification*, which is the greatest irregularity of the disease. Mortification, also, like resolution, commonly happens in the *formative* stage. This result also takes place, in most instances, when that stage has reached a very high intensity. Exceptions, however, as to the force of the disease, occur in dry gangrene, in the gangrene of old men, and in white gangrene (*Med. and Physiolog. Comm.*, vol. ii., p. 319, &c.). Irregular effusions are more or less attendant on this mode of termination.

736, *b*. What is the cause of mortification? It can be only said of it, that there happens a profound alteration of the properties and actions of life, which results in their extinction, and that this change is of a vital nature and not dependent on mechanical causes, as supposed by the physical theorists, unless the circulation be artificially interrupted, and as practiced by these theorists with a view to an interpretation of a natural process. But this mode of death is as easily comprehended as that from fever, or hydrocyanic acid, &c. (§ 54–56. Also, *Med. and Physiolog. Comm.*, vol. ii., p. 171–173).

736, *c*. By what process is the dead removed from the living parts? Here, again, we have, from most physiologists, a mechanical rationale which shall be consistent with the more important steps in their philosophy of inflammation. The dead parts, say they, are removed by the impulse of the *vis a tergo*. But I apprehend the process to be exactly the same as that by which a thorn is removed from a living muscle, or a scab from an ulcer. Each is, in the same relative sense, a foreign body, and each brings into operation, for its own removal, the laws which are represented in section 733. The dead part, like the thorn, excites inflammation in the surrounding tissues, suppuration and ulceration set in, the absorbents carry off the portion of the living matter contiguous to the foreign bodies, and thus is their separation effected. The process of granulation completes the cure (*Med. and Physiolog. Comm.*, vol. ii., p. 167–172). Or, turning to the analogy supplied by the vegetable kingdom, will it be surmised that the removal of the dead parts of plants depends upon the mechanical action of a *vis a tergo?*

737. Another irregularity of inflammation respects the period of its different stages, one or more of which may be accelerated or protracted beyond the ordinary time. This is often true of the *formative* and *restorative;* and since the formative may be long continued, and then result in resolution, we see the importance of holding morbid anatomy subordinate to the vital signs of disease.

The *restorative* process varies, also, as to its *course*. Granulations sometimes fail of approximating a level with the skin, when the true cicatrix may fail of being formed, and in the place of it appears a scabby substance, or some other imperfect formation, and often readily liable to absorption. At other times the true cicatrix is suddenly removed, the granulations absorbed, and the ulcer reproduced.

738. *Scirrus* is another distinct irregularity of inflammation. Here

the action is modified in a very remarkable manner, and is obstinately retentive of that peculiar modification. It is so far analogous, however, to common inflammation, that one of its worst results is an effusion of coagulable lymph, but in some modified condition. It has been lately denied by the physical theorists that scirrus is an imflammatory affection (*Med. and Physiolog. Comm.*, vol. ii., p. 321–330).

739. The products of the second stage of inflammation, pus, lymph, or serum, are liable to deviations; denoting special modifications of the pathological conditions upon which they depend (§ 733, *f*). Besides the obvious and well-known variations from the proper pus of common inflammation, there are other varieties which neither sense nor chemical analysis can detect; as in small-pox, and lues. It presents, also, certain obscure peculiarities according to the nature of the tissue by which it is generated (§ 133–137); and this is also true of the morbid production of serum (*Med. and Physiolog. Comm.*, vol. ii., p. 197, 198).

740, *a*. Every variety of product has its special pathological cause, which it is the great end of art to comprehend. It is the best observation ever made by Andral, that,

"We are not to suppose that the qualities of the purulent secretion are affected by causes which operate locally. The qualities are likewise modified by every alteration, whether physiological or pathological, which takes place in any other organ, no matter how far removed from the seat of the suppuration, even though it have no particular connection either of function or tissue. Thus, we have all seen instances of the pus secreted by the surface of a sore becoming suddenly altered in quantity and quality, under the influence of a simple moral emotion, of the process of digestion, of the diminution or increase, whether natural or artificial, of any of the secretions, or, in short, of any supervening disease. Nay, farther, there are certain constitutions, certain idiosyncrasies, which modify the qualities of pus, and in which it constantly assumes a peculiar and determinate character. There are some persons, for example, whose organs, when irritated, never furnish any other than a thin serous fluid; in others it is always blood more or less pure which is secreted; while in a third class of persons the place of pus is supplied by a grumous fluid," &c. (§ 134, 135, 222–232, 500, 585, &c., 593, 709, 733 *f*, 830, 847 *d*).

Thus have I quoted from Andral a luminous confirmation of the doctrines of vital action, of sympathy, &c., as laid down in these Institutes; and I have adopted it on account of the force which it derives from emanating from a physical theorist of disease, and the distinguished restorer of the humoral pathology.

740, *b*. Nor have I yet quoted all from Andral, that is expedient, in this place, on a subject where vitalism and solidism may establish their firm foundation; and this, too, by the most absolute, unguarded concessions from the opposite school.

Let us hear, then, once more, the great modern humoralist. Thus:

"All attempts to modify the qualities of the suppuration by local treatment, in scorbutic and scrofulous subjects, are utterly ineffectual; for it is the system at large, and not merely the suppurating surface, which is deranged in nutrition and secretion. We must commence the treatment by endeavoring to modify the whole process of nutrition, innervation, and hæmatosis."—And again: "We do not know what

the peculiar modification is which the texture of an organ undergoes, so that in one case it allows the blood determined toward it to escape from its vessels; in another it forms pus, or exhales only a thin serum; while in a third, it becomes indurated, softened, and ulcerated; but *there is a common link which unites these different alterations;* and hence it is, under the influence of apparently the same cause, we often see them produced indifferently, *and not unfrequently replaced one by the other* (§ 732, *a*). But, in all this series of phenomena, we can perceive, throughout the whole course of the disease, *one constant lesion*, namely, the *hyperæmia*, and a succession of morbid alterations in the organic action of the tissue affected, producing, alternately, the results already mentioned" (§ 672, 733 *e*, *f*).

Here, then, are pure vitalism and solidism, because the writer was specifically concerned about matters of fact. The same principles, exactly, apply to all other actions and results which deviate from the natural condition of the body (§ 64, 345–350, 350¾ *n*, 699 *c*).

741, *a*. Again, here is another important practical and philosophical fact, which distinctly evinces the dependence of all the foregoing conditions, changes, &c., upon purely vital actions. A suppurating surface may be so affected by *constitutional* influences, by disordered digestion, that the same results may follow as when the change is produced by some *local* irritant. This proves that the modifications of pus, and therefore pus itself, are not owing, as commonly maintained, either to a degeneration of the blood, or of the tissues, or even to changes of organization, but to certain modifications of the vital properties by which organization is animated; since it would be absurd to suppose that indigestion, and some caustic or other irritant applied to the ulcer, would determine the same physical changes.

741, *b*. From what has been now and before seen, we may insist upon one of the most important conclusions in medical philosophy, which strikes at the whole foundation of humoralism, and is unsurpassed in its practical bearings. We may conclude, I say, that when serum, or lymph, or mucus, are diverted from their natural condition by disease, that the modification depends, in each instance, as much upon certain special physiological changes, as do their natural states upon the natural condition of the solids. This analogy prevails throughout all other natural products, of an organic nature, when turned from their common standard; and were there no other facts, the analogy would establish the same principle in relation to all new formations, as pus, &c. But, such facts I have multiplied abundantly in another work. All the varieties, every shade of difference, arise from modifications of action which are always necessary to the several varieties, respectively. The vital properties must be so modified in the several cases, that the capillaries, acting in obedience to these properties, shall decompound, and recombine, the particular elements and constituents of each product, and in their proper ratio, and modes; rejecting all the rest. Otherwise, indeed, there could be no resemblances among the natural or morbid products, no gradations from one to the other, no obvious coincidence between certain morbid lesions of the solids and the resulting products. Every thing would be confused; there would be nothing but the riot of the chemical forces; and even empyricism would look on in dismay. The physical theorists, therefore, are forever involved in inconsistencies

excepting their universal collision with facts, and suiting hypotheses to each particular occasion (§ 42–52).

But the properties of life can never undergo any change of their essential nature till they are verging toward a state of extinction. Hence the analogies among diseases, according to the nature of the remote causes. It is a great foundation of the healing art; and were it otherwise, medicine would be utterly fruitless, a mere creature of circumstance, one perpetual experiment (§ 638, 780).

The considerations which I have now made enforce, particularly, a critical reference to the pathological conditions in all our prescriptions, their seat, the influences which surround them, the precise adaptation of remedies as to their nature, dose, time and order of their exhibition, &c. They demonstrate, also, the distinction among remote causes of disease, especially such as have their origin in morbid or healthy processes of living beings, and establish the fact that the same disease cannot be produced by the products of organization and of chemical decomposition (§ 653).

741, *c*. We may now glance at one or two important facts connected with the foregoing subjects. Thus, it is important to bear in mind that it is the tendency of inflammation to confine itself to that tissue in which it springs up, along which it is propagated especially by continuous sympathy; though exceptions often occur (§ 133, 141, &c., 498, 500). What is true of inflammation in this respect, is probably, also, of other morbid states. The reason is to be found in the natural modifications of the vital properties of the different tissues. This modification existing in different parts of one and the same continuous tissue, commonly limits the continuity of inflammation to a particular part of the tissue, though it often spring up in other parts of the tissue by remote sympathy (§ 134, &c., 500, 674 *d*).

The foregoing general limitation of any given form of disease to the tissue first invaded (excepting as other tissues of the same compound organ are more or less disturbed in function) is especially remarkable of the *common* form of inflammation, and of diseases that are not distinguished by obstinate conditions, such as specific inflammations with strongly-marked characteristics; as scrofulous, venereal, carcinomatous, &c. (§ 149–151, 525–531).

REMOTE CAUSES OF INFLAMMATION.

742. The remote causes of inflammation fall under the general considerations already made (§ 644–666). As all the agents which contribute to its production must be included in the category, such as are naturally salubrious, or necessary to the purposes of life, as food, &c., sometimes fall within the comprehensive class. It is mostly, however, the abuse of such agents which renders them predisposing causes; but they may readily prove exciting when other causes have laid the foundation of predisposition.

743. It only remains to be added upon this subject, that I cannot agree with distinguished vitalists, that stimuli are alone the predisposing causes of inflammation and fever; but there can be no doubt that a right decision of the question is of practical importance. Upon it may depend, for example, the proper treatment of cerebral affections arising from excessive doses of opium. In excessive doses, it is generally conceded to be directly sedative; and yet is profound

cerebral congestion one of its morbific effects, for which bloodletting is the most efficient remedy. Hydrocyanic acid will do the same thing, which, in like manner, is best relieved by loss of blood (§ 483, 484, 494 *dd*, 827 *d*, 828). And so of extreme cold, the philosophy of which is set forth in the Commentaries (vol. ii., p. 478–493.) Tartarized antimony is powerfully sedative in all its doses, and the larger the more so. Yet in its over-doses it produces a serious form of inflammation. Even excessive bloodletting may lead to inflammation, for which the farther abstraction of blood by means of leeches may be useful (§ 1024).

Concentrated miasmata, when followed immediately by an attack of fever, evidently depress the powers of life, as one of the first changes which they establish (*Commentaries*, vol. i., p. 471–474). We must take the facts as we find them, and build our theories accordingly. And here we see the importance of looking well to the characteristics of the properties of life, at their wonderful mutability, observe how they may be profoundly altered at the moment when certain morbific causes begin to operate, how they may go down in an instant to a state of extinction; and how, on the other hand, every restoration from disease is the result of their own constitutional tendency to return, through a series of changes, suddenly or gradually, to their natural state (§ 175, 177–185, 672, 733 *e*).

These considerations enable us to understand how the properties of life may be as readily affected by depressing agents or sedatives as by stimulants, and how, when affected by the former, they may speedily react and constitute the absolute conditions of inflammation and fever (§ 666), or return at once to their natural state (§ 150, 151, 227). When either of these morbid conditions actually ensues, there can be no doubt that the organic properties have undergone an exaltation as well as another modification in kind. The physical philosophers will allow nothing but absolute prostration, and a passive relaxation of the vessels, when high arterial action sets in; but they look upon the cold stage of fever as being best explained by something like the "glacier theory." And yet, if we go to the simple facts attendant on the very invasion of fever, we shall find in the universal contraction of the capillary vessels, during the cold stage of fever, abundant proof of the exaltation of mobility and irritability; and this is farther confirmed by the salutary effects of two most depressing agents, bloodletting and emetics. See, too, how local inflammations are becoming generated during this stage; and when the hot stage supervenes, and when, also, in progressive order, the secretions break forth, we have the most unequivocal demonstrations of exalted powers; though here, as in inflammations, this change is only an inconsiderable part of the alteration which the properties of life sustain (§ 188½, 487 *h*, 569, 675, 764, 964).

Still, however, in respect to inflammation, its most common causes are directly stimulant, and exalt the vital properties and actions by their direct operation; but this appears not to be equally true of idiopathic fever (*Med. and Phys. Comm.*, vol. ii., p. 213, 241–248, 277–280, 288, &c.).

PATHOLOGICAL OR PROXIMATE CAUSE OF INFLAMMATION.

744. "The act of inflammation," says Hunter, "appears to be an increased action of the small vessels. It is commonly supposed to be contraction of the vessels; but I have shown that their elastic power also dilates them, and I have also reason to believe that their muscular power has a similar effect."—HUNTER, *on the Blood*, &c.

"The blood," says Magendie, "traverses with ease the infinitely more minute tubes that abound in our tissues. There must be some particular conditions to facilitate its passage. What proves their existence is, that if certain alterations are effected in the composition of the blood, it stops, undergoes morbid changes, becomes extravasated and decomposed, and *produces the various disorders* which pathologists have vainly attempted to explain by the words INFLAMMATION and IRRITATION. What sense, in truth, is there in applying the word *inflammation* to our organs? Do our tissues actually *take fire?*" [So says Vacca, and Magendie is of his school.]—MAGENDIE, in *London Medico-Chirurgical Review*, January, 1839, p. 208.

"For my part, I declare boldly, that I look upon these ideas about VITALITY and the *rest of it*, as nothing more than *a cloak for ignorance and laziness*." "All the physician can do is to order remedies, which, if necessary, the *nurse could prescribe equally well*." "You saw me give rise, *at my pleasure*, to pneumonia, *scurvy*, *yellow fever*, typhoid fever, &c., not to mention *a number of other affections which I called into being before you*."—MAGENDIE'S *Lectures*.—And that, too, upon animals.

"Pythagoras," says an ancient philosopher, "looks at the sun very differently from Anaxagoras. The former carries his eyes into it like a god, while the latter looks up to it as unfeelingly as a stone" (§ 699, 709, 810, 838.—Also, *Medical and Physiological Commentaries*, vol. i., p. 510–515, text and notes, 518, note, 526, 539, 567, note, 584, 611, 650, notes, 697, 698; as to *Magendie*),

745. No subject has excited more discussion, or more deservedly, than the pathology and cause of inflammation, since this affection and idiopathic fever comprise most of the diseases of man, and since, also, the treatment of disease turns mainly upon our conceptions of its pathological character (§ 4, 667–677).

The example of inflammation involves the whole philosophy of all other diseases; and, if our views be right in respect to this affection, we shall have little difficulty with any other. This I shall endeavor to show by a special consideration of fever and venous congestion. The general laws are the same in all the cases; though the results are variously modified. There may be, for instance, in one form of disease, increased action of the extreme vessels, an exaltation of the vital properties, &c., while in another form, an opposite condition may obtain. Yet these opposite states shall depend upon the same great general laws. In either case, for instance, it is a general law that an altered condition of the organic properties constitutes the essential pathology; and, it is another general truth, that this altered condition has been instituted by deleterious agents. The changes in function will also correspond with the particular changes of the organic properties. But, coming to the details in respect to the exact nature of the changes, we find them different in the different cases; and they

depend mainly upon the specific nature of the remote causes, which have altered the properties of life in one series of cases in a different manner from the other series (§ 652). These, therefore, are only contingent results, and do not affect the great laws which are concerned about the essential pathology of disease.

746, *a*. The extreme terminating series of the arterial system of vessels are the immediate instruments of inflammation. They are endowed with muscular fibres, and possess, naturally, the function of active contraction and dilatation (§ 384–387, 397–399). That such are the essential instruments is evident from a variety of facts, of which, however, it is only necessary to state one, namely, the analogy which subsists between the process of nutrition and the reparative process of inferior animals and the formative and adhesive stages of inflammation; while the true suppurative, and all its modifications, are analogous to the general function of secretion (§ 729, 732 *a*). The effect of cantharides, &c., applied to the skin, is an example in illustration. All this, too, corresponds exactly with what is known of the greater development of the properties of life in the extreme vessels; which, it may be now said, supplies an important proof of their increased action in inflammation (§ 407 *b*, 410, 411).

Such, too, are some of the numerous instances in which we reason with certainty from analogy, especially in relation to organic life; while the conclusions are corroborated by all the relative facts.

I have thus thought it important to indicate with precision the instruments of inflammatory action, that they may not be confounded with that series of capillary vessels which serve mainly as reservoirs to the extreme vessels, and between which there is also a broad distinction in their vital states. We shall have accomplished much in establishing the vital character of inflammation, and in exposing the errors of the physical hypothesis, by the plain fact whose statement is made as a point of departure and for the government of the whole inquiry. Those vessels, as I have endeavored to prove, are eminently characterized by the attributes of life, and I hold it to be fundamental, and cannot be denied, that what is physiologically true is true, also, of those morbid states which coincide in their general results with the physiological (§ 41–44, 48, 52, 134, 135, 136, 409 *c*–411, &c., 516 *d*, no. 6, 524 *a*, no. 1, 526 *a*).

If such, therefore, be founded in nature, the essential philosophy of inflammation is to be found in modified states of the natural properties and functions of the extreme series of the arterial system.

746, *b*. The absorbents, also, are interested in the ulcerative process, and are, therefore, modified in their action.

746, *c*. The nerves, from constituting a part of all the tissues, and from the liability of every part to be affected by preternatural determinations of the nervous power upon them, and being, also, the organs of sensibility, are so far liable to a participation in the pathological states of inflammation (§ 188, &c., 194, &c., 205, &c., 222, &c., 526 *d*).

From all that has been said, it is evident that the nervous power can only act as an exciting cause of inflammation, and that the conclusion is unavoidable that all the remote causes of inflammation, as of every other disease, produce their morbific effects upon the organic properties, that the morbid processes are carried on by these properties, as in the vegetable kingdom, and that the nervous system is not

necessary to the disease, however it may have an accidental participation (§ 183, 184, 222, &c., 476, &c.).

The nervous power, it is true, is the immediate remote cause of all inflammations which spring up sympathetically, but it forms no part of the essential pathological cause; nor are the nerves in any other way the medium through which inflammations are excited (§ 201–204, 226, 233, 500, 715, 725 *c*).

On the other hand, the physical philosophers, with singular inconsistency, maintain that the "nervous influence" has an important agency in the inflammatory process, though they do not say in what that inflammation consists, or how it co-operates either with mechanical or chemical agencies.

747. Hunter laid the foundation of the true theory of inflammation He supposes that the vessels are in a state of increased action, both as to contraction and dilatation, and that, in a general sense, they carry an increased quantity of blood.

Irritability and mobility, the two great properties upon which organic actions mostly depend, are probably always increased and otherwise variously modified in all inflammations. In consequence, also, of the increase of irritability, all inflamed parts are more than naturally susceptible of the action of stimuli, though not according to their ordinary effects in health. It is a general law, indeed, in respect to all diseases, that the natural relations of the affected parts to physical and moral agents are more or less altered; and upon this turns, mostly, the curative action of medicine, &c. (§ 143, 149–152). It was a radical defect in Hunter's doctrine that he did not consider the altered condition, in their very nature, of the vital properties, but imputed the essence of inflammation to a simply "increased action of the powers of the part." If the hand be plunged into warm water, there ensues an increased action of the vessels, but there is no inflammation.

748. A theory opposed to the foregoing, and now universally adopted by the physical school of medicine, supposes,

1. That the vessels concerned in the process of inflammation are passively relaxed.

2. A progressive accumulation, stagnation, and coagulation of blood within the vessels (§ 789).

3. An enlargement of the collateral vessels proportioned to the redundancy of blood transmitted to the part, occasioned by the force of the *vis a tergo*.

4. That the blood is propelled through the collateral vessels by the action of the heart (§ 392).

5. That the vessels, being paralyzed, relaxed, and mechanically obstructed, can perform no part in generating the products, or in those processes already described as the results or "terminations" of inflammation; but, on the contrary, that all the fluids are mechanically strained off from morbid blood, notwithstanding the mechanical obstruction occasioned by the coagulation, and that ulceration is only a mechanical softening of the living solids. (See "*Report of the recent State of Knowledge of the Nature of Inflammation*," by Mr. Wharton Jones, in British and Foreign Medical Review, April, 1844.)

749. Such is the prevailing mechanical doctrine of inflammation, which, in conformity with the plan of this work, I have here intro-

duced as appearing to me the most adverse to facts and philosophy, but sustained by a powerful school. I shall not enter upon its farther refutation, nor upon the proof of the vital theory, beyond the statement of a few prominent facts. Both of these objects I have endeavored to accomplish in the *Medical and Physiological Commentaries*, nor have I seen any fact whose import is not there considered (vol. ii., p. 141–214, 224–397. Also, my "*Introductory Discourse*," p. 22, &c., 1842, in vol. iii.).

The mechanical doctrine of inflammation has grown out of experiments by which Nature is misrepresented. I mean that such is my opinion; but not without its attendant reasons. One experimental fallacy, however, lies mainly at the foundation of all the foregoing conclusions, which consists in the means by which inflammations are artificially produced for the purpose of arriving at a knowledge of their pathology. Irritants of a chemical nature have been applied to delicate membranes, by which their organization is impaired or destroyed, and the blood also coagulated by direct chemical influences. The part has been then subjected to the microscope, under the direct rays of the sun, whose heat has the effect of drying the disorganized tissues, and consolidating the blood.

From such most unnatural results the whole organic process of inflammation, its formative stage, the stages of suppuration, ulceration, and the secretion of lymph, of serum, &c., are interpreted upon purely mechanical principles (§ 396, 410).

But, if this were true of inflammation, it should be equally so of the analogous results in the healthy state of the body; and growth itself, and all the secreted products, should be equally determined by mechanical laws. Were the doctrine, therefore, founded in nature, it would completely overthrow the whole science of physiology, and reduce the living being to a mere automaton (§ 639 *a*, 746 *a*).

750, *a*. We have already variously seen what analogy prompts. We have seen, too, that it has been demonstrated that the blood is accelerated in the capillary and larger vessels, when stimulants are applied to them, or to the brain or spinal cord, and that they give rise to alternate actions of contraction and dilatation, even in the veins (§ 384, 387, 392, 399, 408–411, 480–485, 498 *e*). We have seen how the extreme vessels become enlarged and admit the red globules (§ 192). We have seen, physiologically, that all the vessels must have an independent vital action (§ 382, &c., 407, 410, &c.). And now I ask the physical philosopher, upon his own ground, how the extreme vessels in dense structures, such as ligament, cartilage, and bone, acquire their great enlargements in their inflammations? It is evident that the physical philosopher has limited his views, as he has his experiments, to soft, delicate membranes. He has reasoned from an isolated fact, and that fact evidently of a spurious nature (§ $5\frac{1}{4}$, *c*).

That there is generally, though not invariably, an increased volume of blood circulating in the instruments of inflammation, is shown by the increased quantity of blood which flows from the veins of an inflamed part; by the high florid color of the part, and of the blood; by the profusion of blood which follows scarifications and leech-bites; by the rapidity with which the blood returns when expelled, by rubbing, from an inflamed surface; by the actually increased fluidity of the blood proceeding directly from the seat of inflammation, as shown

by its slower coagulation than in health; by the preternatural generation of heat, which even no chemical theory can explain without admitting an increased circulation of the blood; by the profuse secretion of certain fluids, and their specific nature; by the frequently increased pulsation of an artery leading to an inflamed part, and especially as the pulsation is often strongest when the general circulation is prostrate, and again, on the other hand, as the throbbing of the vessel often subsides when the force of the general circulation rises under the influence of the lancet; while the local inflammation may go on increasing, &c.

750, *b*. Coincident with the numerous physical and pathological facts which lie at the foundation of the vital doctrine of inflammation are the effects of remedial agents; since bloodletting, cathartics, antimonials, and other depressing agents, should increase the supposed relaxation of the vessels, and stagnation of blood, both by their direct action and by diminishing the force of the *vis a tergo;* while, on the other hand, tonics and stimulants should be the prevailing means of cure. Nor can the curative effect of the former agents, nor the morbific of the latter, be interpreted on any other than physiological principles. How, again, will the physical philosopher explain the instantaneousness with which moderate bloodletting, nay, even syncope without the loss of blood, will sometimes overcome pneumonia, inflammation of the brain, &c. (§ 951)? How explain the rapidity with which croup will yield to the prostrating effect of antimonials; or how deep-seated inflammations take their departure as soon as the same condition is produced in the skin by cantharides, or yield more gradually to the silent influences of antimony, ipecacuanha, mercurials, iodine, colchicum, guaiacum, veratria, quinia, &c., according to the special modifications of the disease by its various remote causes (§ 150, 650–653, 662 *b*, 668, 669, 672, 674, 742)?

751. I have just intimated that, if vital action do not exist, there should be no varieties of inflammation. It should be all small-pox, or lues, or rheumatism, or, at least, all of the common variety. The vital phenomena and physical products should be always the same; the same in all tissues and in all constitutions (§ 409, *c–i*). Nor should we have any remarkable and diversified sympathetic influences of inflamed parts upon the system at large (§ 500, 512–530). The vitalist supplies the only intelligible solution of the facts which are presented in real life. He points to the various modifications of the organic properties, according to the peculiarities of every tissue, the diversities of the remote causes, constitution, age, sex, &c., which he believes, also, to be the foundation of all rational pathology; and upon the same principles he interprets the curative effects of remedies.

Active and Passive Inflammation.

752. I endeavored, originally, in the *Medical and Physiological Commentaries*, to show the fallacy of the distinction of inflammation into *active* and *passive*, and to prove the dependence of all forms of the disease upon one general pathological cause; and I shall now briefly advert to the manner in which the principles set forth in the present work establish that conclusion.

753. In the *active* form of inflammation there appears to be a vague recognition, so far as the verbal distinction goes, of the morbidly-in-

creased action of the part, while in the passive form, all is "relaxation" and "stagnation" (§ 748). These exactly opposite states of verbal pathology are especially characteristic of the school who maintain that inflammation is always constituted by a passive relaxation of the vessels and coagulation of blood. With the same consistency they also affirm that the two nominal conditions require opposite modes of treatment; though, in justice to the real hypothesis, it should be said that the stimulant plan is apt to prevail. There are many authors who speak of an active and passive state of inflammation as things in absolute opposition, but they attempt no explanation of the supposed distinction.

Andral perceived that the term *active* is not in harmony with the mechanical philosophy of the disease, nor with his own views as to the abolition of the general term; and he therefore substitutes *sthenic* and *asthenic* to express the opposite conditions, and *hyperæmia* in the place of inflammation. But the epithets are as much in direct opposition as *active* and *passive* (§ 699, *c*).

754. But it requires only a right exercise of judgment to understand that the same disease cannot be constituted by opposite pathological conditions (§ 741, *b*). The supposition contradicts itself. The varieties depend simply upon partial modifications of a common pathological cause; and this conclusion, as abundantly exemplified, is of no little practical importance (§ 766). The term *passive* can only be intended, by those who use it, to inculcate a stimlant treatment, and that mechanical condition of the blood-vessels whose refutation I have attempted extensively in the *Commentaries.*

755. Again, in the supposed opposite conditions, the vital signs, and the morbid products, are nearly identical; which evinces, sufficiently, a close affinity in the pathological states, while the analogy between those products and such as depend on the natural processes places both modifications of the disease on a common physiological foundation (§ 137 *e*, 150–153, 639, 746 *a*).

756, *a*. The occasional success of tonics and stimulants in the treatment of inflammation, whether applied internally or externally, or with or without antiphlogistic remedies, is no evidence, as supposed, of a pathological state manifestly different from that which is most readily surmounted by loss of blood, cathartics, &c., alone. This will be obvious when the true *modus operandi* of remedial agents is duly considered (§ 150–152, 638, 893, &c.). It is also well known that a sudden and powerful impression even from alcoholic stimulants will sometimes subvert an inflammation or a fever of great activity, which, under apparently the same circumstances, would be aggravated by such treatment in the hundred next following cases, but where loss of blood, &c., would be speedily curative in nearly all (§ 900, 904 *d*). The disciples of Brown have been thus enabled to sustain themselves in the midst of general failure.

Take a clear example, which illustrates the only distinction, so far as principle is concerned, between the supposed opposite conditions of inflammation. Such a one occurs in this disease when modified by the predisposing cause of intermittent fever. Here the Peruvian bark may be as necessary to its cure as the loss of blood, though the latter is commonly, also, indispensable. And there occurs to me a proof from analogy which demonstrates the vital doctrine of inflammation;

which consists in the fact that the Peruvian bark is also a specific for intermittent fever, while, as with inflammations, it will aggravate other forms of fever. If, therefore, it be admitted that there is no "stagnation of blood" in the intermittent and other fevers, it clearly follows from this analogy that there is none in inflammations.

The intense inflammations attendant on scurvy often yield only to such remedies alone as improve the digestive organs, of which tonics may be one; and here we witness impressive demonstrations of the laws of sympathy (§ 500, 512, &c.). And yet in the same conditions bloodletting may be simultaneously appropriate or necessary. Opposite modes of local treatment succeed in burns and scalds; catarrh is often cured by "gin sling;" erysipelas has frequently yielded to the tonic and stimulant practice, though at the hazard of life; and typhus fever, with its train of local inflammations and congestions, divides the medical world into the two opposite systems of treatment.

Again, the most feeble subjects are quite as likely to require the depletive treatment, in grave inflammations, as the robust; and long-continued chronic inflammations have often yielded to a repeated loss of blood where tonics had been employed under the illusive doctrine of passive inflammation (§ 1007 *b–d*, 1008).

The differences in small-pox, varioloid, and cow-pox, which are essentially one disease, illustrate the principles before us. So, too, do all the varieties attendant on specific forms of inflammation, as measles, scarlatina, lues, rheumatism, &c. Lues yields especially to mercury; rheumatism to colchicum and guaiacum; scrofula to iodine, &c.; and yet the simultaneous loss of blood may be more or less useful or indispensable. The example of tuberculous phthisis is illustrative of our whole subject. A mixed, or even a stimulant, treatment is slow in its destructive effects; and its evils have been, therefore, overlooked in the speculative views which morbid anatomy has suggested as to the nature of the pathological change in which tubercle originates (§ 695, &c.), and in the brown chicken-meat which chemistry has contradistinguished from the white. This morbid condition has been recently and extensively considered non-inflammatory, and as supposed by Louis, when the most extensive inflammatory lesions and products have supervened; and it supplies us with another exemplification of the irresistible tendency of theory, true or false, to determine the treatment of disease (§ 4). The antiphlogistic practice has been abandoned. But what are its results? Has the mortality from phthisis diminished? On the contrary, it has most fearfully increased (*Medical and Physiological Commentaries*, vol. ii., p. 622–633, 743–752).

756, *b*. However varied may be some of the remedies in the different modifications of inflammation, the general principles of treatment are substantially the same. The incidentally favorable effect of local or constitutional stimulants is no proof that the pathological conditions of inflammation are not closely allied. It only proves their effect in altering the vital properties in such a way as will enable Nature to take on the restorative process. Least of all can opposite principles prevail at different times and in different climates. It has been so from the earliest records of disease. Otherwise, medicine would consist only of an unconnected series of observations. There would be no principles, and of course no science. Medical learning would

be useless, and experience would only suit the present occasion. A new system of treatment would have to be devised for every climate, every constitution, and every reappearance of the same disease.

But Nature is not thus the creature of accident. It is not Nature who is inconsistent, or who operates by conflicting laws. Art may give her this appearance; but still I say, that "Nature can never deceive." It is owing to this consistency of Nature that medicine had long since become a noble science; difficult and concerned about all other sciences, and therefore taking the lead of all others. A science of principles deduced from the phenomena of Nature, and which, with the facts that are known, conduct us with remarkable certainty to facts that are unknown. It is here that well-founded principles enable us to see farther than the senses, and to learn from a single vital phenomenon, from the expression of the eye, the existence and nature of those latent changes which too many can only see when seeing is useless, and bring upon art and philosophy the derision of the crowd (§ 704).

A sound principle in medicine is like the calculus in mathematics; and what are falsely called "exceptions to general principles" are nothing more than variations in phenomena, which arise from the instability of the properties of life, and the vast variety of influences to which they are exposed (§ 177–179, 237). These variations may denote only partial modifications of a common morbid action, arising especially from differences in the remote causes (§ 644, &c.); or, they may depend upon the same action affecting different tissues; or upon the morbid condition of particular organs affecting certain other organs, or all others (§ 117, 129, 134, 137, 529, &c.); or, upon age, sex, constitutional peculiarities, and other accidents (§ 335, &c., 570, &c.). And, although there be one leading principle in the treatment of such cases, there are other subordinate ones founded upon the modifications. These are to be nicely balanced, that the governing principle may be properly directed (§ 675). But, it is only men of correct thinking and close observation that can apply these principles. All others will look upon the variations of symptoms from their usual state in any one disease, or upon the differences in the results of an exact methodical practice, as denoting very different pathological conditions, or as constituting "exceptions to general principles;" and "bark and wine" will therefore obtain in numerous cases where bloodletting is the only efficient remedy.

FEVER.

757, *a*. Important distinctions between the two great classes of disease, Inflammation and Fever, have been already sufficiently indicated. The former, as we have seen, is limited to certain parts, while the latter invades the body universally from its beginning. I have reserved for this place, however, a fundamental distinction, which, as a characteristic of inflammation, has been described. This consists of the morbid products, new formations, and lesions of structure, to which inflammation gives rise. It is otherwise with fever, whose distinguishing phenomena are mostly of a vital nature, and whose morbid physical products consist only of modifications of the natural secreted fluids (§ 764, *e*). Morbid anatomy, therefore, reflects no light whatever upon the pathology of fever. And yet is its treatment, all

its varieties, as well ascertained as that of inflammation and its varieties. Indeed, of most of the varieties of inflammation morbid anatomy does not afford the least information; and yet is the specific treatment of the most common and important, such as rheumatism, gout, intermittent, scrofulous, &c., as well known as the general remedies for inflammation. And so with the varieties of fever. I say again, therefore, that the morbid anatomist may not appropriate what so eminently belongs to the acumen of genius in its philosophical observation of the phenomena of nature (§ 695, &c.).

It is plain, therefore, that all those who would render morbid anatomy the principal basis of pathology can have no definite views of disease. The effects are mistaken for the cause; and if the former be not present, the case is regarded as inscrutable in respect to its pathology. Every disease is, of course, to the morbid anatomist circumscribed to the organs which tell upon his senses; the varieties in inflammation are overlooked from their want of tangible distinctions; and as ulceration, &c., and other lesions of inflammation, may happen to appear red or white, they are denominated, as by Louis, inflammatory or contra-inflammatory.

757, *b*. Many of the ordinary and most characteristic symptoms of inflammation are wanting in fever; such as hardness and incompressibility of pulse, buffing and cupping of the blood, local pain, &c. This is very obvious in intermittent fever. Exalted heat probably takes place in all inflamed parts; but a sunken temperature is common in fever (§ 712–722).

758. Fever, like inflammation, has numerous modifications, as a necessary result of the constitution of the vital properties, the variety of morbific causes, the unequal distribution of the disease, &c. These modifications have given rise to the distinctions of *continued*, *intermittent*, *remittent*, *typhus*, *nervous*, *bilious*, *yellow fever*, *plague*, &c. But strong analogies prevail among the whole; the general pathological cause, as in inflammations, being essentially the same. Most of the varieties in fever depend, indeed, more or less, upon the modifying influences of coexisting inflammations and venous congestions, though more so upon the predisposing causes, while, also, the modifications which grow out of these local affections will depend much upon their particular seat. Some organs, also, sustain a greater burden of the febrile disease than others; and this, of course, will give to every case certain peculiar modifications (§ 134, &c., 644, &c.).

759. Fever, in its most simple form, is of short duration, never continues three days, rarely longer than twenty-four hours, and sometimes terminates within four hours. This is the *ephemera*, which may be taken as the type of the complex forms that consist of a series or repetition of paroxysms.

The foregoing may be also noticed as a broad fundamental distinction between fever and inflammation; since the ephemera, a perfect representation of fever, may sweep through its course, and terminate as suddenly as it invades the body, and in less than twelve hours, and leave scarce a vestige of its former presence behind.

760. If fever, therefore, be continued beyond a single paroxysm, it is made up of a succession of paroxysms. Many have supposed that every compound case consists of as many fevers following each other as there are paroxysms. This, however, is not pathologically true;

since the same morbid predisposition, in which the first paroxysm originated, remains, and is the cause of each succeeding paroxysm, and, therefore, a connecting link among the whole. The supposed distinction consists only of periodical abatements of one continuous disease (§ 514 *g*, 516 *d*, no. 6, 665, 666).

761, *a*. The foregoing abatements of fever are the results of salutary efforts of nature, and are variously pronounced as to their degree and duration (§ 733). They are most perfect in intermittent fever, in which they vary from a few hours' duration to one or more days (§ 675).

761, *b*. These abatements of fever, often amounting to an apparent termination of the disease, supply a fine illustration of the recuperative nature of the properties of life, and of their inherent tendency to maintain themselves in a state of integrity. We see, too, the *modus operandi* of art in its co-operation with Nature, when, by the interposition of remedies, the natural abatement of fever is confirmed by new influences that are different from the original morbific ones (§ 675, 897, 898, 901).

762, *a*. Each paroxysm of fever consists, in a general sense, of a certain succession of symptoms, which, however, are liable to great variations; and new ones that may spring up in the progress of disease, from accidental influences, may present a general aspect more widely different from the preceding than the near identity of the pathological cause would lead us to suppose. These differences spring from the very susceptible nature of the properties of life, especially in their morbid state, and the various new influences which may operate upon them; and the manifestations are liable to exceed the ratio of any change that may be wrought in the vital conditions. A slight change only, some accidental cause, as errors in diet, inflicting morbid sympathies, may give rise to new and striking phenomena, or they may be forcibly presented by the transient effect alone of some momentary cause, as an emotion of the mind.

762, *b*. In presenting a summary analysis of fever, I shall first consider the *Ephemera*. Secondly, fever as constituted by a repetition of the same paroxysm, and in different modes. Thirdly, the remote causes of fever, the coexisting inflammations, &c. Fourthly, the pathological cause.

763. The *ephemera*, as I have said, may be taken as the general type of the entire family of fevers. It generally commences between six or seven o'clock in the morning, or five or six in the evening; a coincidence of difficult explanation, but manifestly connected with some natural periodical mutations in the vital states of the system (§ 768). It has three distinct stages, which are commonly present; namely, the *cold stage* or *cold fit*, the *hot stage*, and the *crisis*.

764, *a*. The first, or cold stage, is the period of the most intense morbid action. Its invasion is marked by a sudden contraction of all the capillary blood-vessels, and consequent determination of blood about the right cavities of the heart, by a diminution of the fluid products, by reduction of temperature, and by a loss, in various degrees, of the voluntary control over the muscles. These are the most obvious changes; and such as relate to organic life evince a universality of the disease at its invasion. Here we may stop to observe another broad distinction between fever and inflammation; since the latter

does not begin in the foregoing manner, but with an enlargement of the capillary blood-vessels (§ 712, &c., 757, 759, 770).

In idiopathic fever, many of the prominent, but less important, vital symptoms, so far, at least, as sensation is concerned, appertain to the organs of animal life. Those of the organic system are less remarkable at first, as natural sensibility is here inferior to its condition in animal life. The eye, for instance, is naturally more sensible than the intestines, and hence an affection of the former is more conspicuous than of the latter, till disease, at least, may develop the property in the intestine. The same rule, in a general sense, will hold as to the individual organs in either division of life, at this early stage of fever, and is applicable to all other diseases. There may be more disease in one organ than in another, yet the symptoms of that which is most affected may be less strongly pronounced on account of its natural inferiority in *sensibility*, and often, also, of *irritability* (§ 133–139, 188, 194).

A preliminary condition, subsequent to the formation of the predisposition, and immediately antecedent to the cold stage, may be recognized under the denomination of *access;* a term which has been employed to denote the cold stage, or the most intense degree of morbid action, and which, being already formed, cannot be regarded as the *access* of disease. Prior to the absolute seizure, however, there is commonly a more or less obvious failure of the living powers to perform any of their functions in their perfect manner; and that constitutes the true *access* of the complaint. The distinction and the term are practically useful as leading to sound pathological views, and to correct treatment.

The development, or attack of fever, is always sudden, whatever the duration of the predisposition; and this is one of distinguishing marks between fever and inflammation.

764, *b*. After the cold stage has continued for an indefinite time, the diseased conditions begin to assume a tendency toward their natural state, or to obey the great restorative law, the *vis medicatrix naturæ*. This recuperative effort introduces the *hot stage*, which is the first part of the natural cure. The prominent characteristics of this stage are an expansion of the capillaries, an increased volume of blood at the circumference, greater force of the general circulation, and an exaltation of temperature above its natural standard.

A spontaneous change has happened in the vital conditions of the whole body. The small vessels expand in consequence. Irritability has become more susceptible, but less profoundly altered, and the blood accumulated about the heart in the cold stage now rouses that organ to greater action, while it receives corresponding sympathetic influences from the changes which are going forward in all parts of the capillary system. An increased volume of blood is thus sent out, and this is harmoniously met by the active expansion which is taking place in all the small vessels (§ 384–387). But this is only a part of the involutions of sympathy which are now in progress.

Notwithstanding, however, the hot stage is the beginning of the natural cure, the symptoms would often denote an increase of the morbid condition, and frequently call for the intervention of art. Nature may be excessive in her aims at reparation. She may overstep her ordinary limit, and push the organs of circulation with a ve

hemence that shall light up inflammations, and call for an outlet of blood as an indispensable means of prevention (§ 674, *d*). But we know, from the general progress of symptoms, and the final result, that a succession of favorable changes has been instituted from the beginning of the hot stage.

764, *c*. The *crisis* follows next. This constitutes the greatest decline of the disease. The phenomena of health are now more or less pronounced. The secretions break forth, morbid at first, but rapidly assuming their natural character. Among these, perspiration is the most obvious; and hence this stage of the disease is universally known as the *sweating*. The designation is too partial and hypothetical, since the volume of bile, or of urine, may be quite as redundant, or more so. *Crisis* is more comprehensive, and implies exactly the things which are in progress. The *hot* stage is better named; for exalted temperature is the beginning of the elaboration of redundant products, and, for a while, it stands alone. And here I may refer to this connected series of physical products, during the curative stage, as showing analogically the dependence of sweat, bile, urine, and the elevated temperature, upon common physiological principles, and that the last is no more a chemical product than the other secretions (§ 419, 447, &c.).

764, *d*. The secreted products, although the result of improving pathological changes, contribute, as in inflammations, to the ultimate design of nature, as depletory remedies (§ 732, 733 *e*, 757 *a*).

764, *e*. In consequence of the foregoing remarks, it may occur to some that there is a greater affinity between fever and inflammation than I have admitted (§ 712, &c.). But that conclusion does not follow from the course of nature in her restorative movements. The cold stage of fever may be the period of the most profound disease, and nature may be emerging toward her healthy standard during the stage of reaction, and yet the apparently analogous excitement of the general organs of circulation, and of the immediate instruments of the morbid process in inflammation, may be the stage of most profound disease; and this is known by the various attendant facts. The pathological conditions, indeed, are so widely different, that the general arterial excitement attendant on inflammation is not, as in fever, followed by augmented perspiration, bile, &c. The increased products are relative to some particular part, and are not of the nature of those which attend the restorative process of fever. In one disease they proceed from a tissue, in the other from compound organs. One affection besets the tissues in their individual sense, the other in their compounded sense. These are, therefore, other broad fundamental distinctions between fever and inflammation (§ 141 *b*, 148, 675, 712–722, 757, 759, 764 *a*, 770).

765. If a repetition of the paroxysm take place, the crisis is always imperfect. Their repeated occurrence is said to form a *compound* fever; but, as we have seen, the disease is as much an entire whole as the ephemera (§ 759, 760).

When the paroxysms apparently go off entirely, the fever is called an *intermittent*. When the interval is less perfect, or a new paroxysm takes place in the middle of a crisis, the disease is called a *remittent*. When the disease continues without much abatement of symptoms, or, rather, if a new paroxysm set in during the hot stage of a prece-

ding paroxysm, it receives the name of *continued* fever. Between the remittent and continued fevers, however, there is no well-defined line of distinction, as it respects the succession of paroxysms. Again, the remittent and intermittent interchange with each other; and it is even common for one attacked with a remittent to have the intermittent form before his recovery. When, also, intermittents are badly treated, they are often converted into a remittent; which is commonly a more intractable form (§ 557).

766. We have thus a series of analogies which connect the continued fever with the intermittent; and when we regard the distinct nature of the paroxysms of an intermittent, we see that the ephemera is a representation of each one. The symptoms also confirm these conclusions; from which we learn, more and more, that the essential elements are the same in all the preceding forms, and other minor varieties of the disease (§ 557, 650, 652, 670, 741 *b*, 754, 756 *b*). The existence of this coincidence corresponds with the like attribute of inflammations; the varieties of which, respectively, are not more remarkable in their vital manifestations and results than are the natural modifications of the vital properties in different tissues (§ 133–137).

767, *a*. Notwithstanding, however, the foregoing analogies (§ 765, 766), the causes of continued fever are so far different from those of the remittent and intermittent, that the first of these varieties does not interchange with the last, as do the last two with each other, although the quotidian and tertian types are sometimes manifested with considerable distinctness during the progress of continued fever. Remittents and intermittents are, also, rare in climates where the continued fever occurs, while the former go together, and have close affinities in their predisposing causes (§ 652, &c.).

767, *b*. We see, therefore, more and more, the fallacy of the doctrine which regards disease as a *unit*, and especially as propounded by one to whom medicine is under the deepest obligations. There are, indeed, no two cases precisely alike in their pathological conditions; and there is scarcely a principle of greater importance (§ 673, 857). It is true of diseases which are most allied, and even true of the same case during its advances or its decline; and coming to the specific forms of inflammation, and passing from those to idiopathic fever and the various modifications of this disease, and regarding in connection, also, the more obscure pathology of the various conditions of the stomach which are grouped under the general denomination of indigestion, and all those states which go to make up the "nervous disorders," we can scarcely fail of escaping from the illusions which have grown out of the physical views of disease, or of turning ourselves to that philosophy which concerns the mutability of the properties of life (§ 177–184, &c., 780).

768, *a*. In a vast proportion of all the cases of fever the paroxysms take place in the afternoon; generally beginning about five or six o'clock, and going off about five o'clock in the morning. This is common to all constitutions; nor is it much regulated by the force of morbid habit, but rather by its association with a natural evening paroxysm, to which all individuals in health are liable, and which happens and subsides about the foregoing hours, even when traveling to the eastward or westward (§ 772, *b*). This natural paroxysm is marked clearly by its phenomena; and the foregoing coincidence shows,

again, how the physiological laws hold their control in disease (§ 133–152, 638). A coincidence is farther seen in a diminution of the secretions attendant on the natural and morbid paroxysm. A purgative given now, whether in health or disease, irritates the system more than at any other time, and produces smaller evacuations than in the morning, especially if rapid in its operation. On the contrary, in either case, if the cathartic do not operate till morning, the discharge will be far more abundant. Toward morning the natural paroxysm subsides, sweating often comes on, and all the functions of the body and mind are then manifestly improved. And so, more or less, with the morbid paroxysm. The former is not connected with the fatigue of the day, since it is common to mankind under every condition of repose, employment, and habits.

Again, the first paroxysm of a fever may take place at any period of the day; the time of the invasion often depending upon some immediate exciting cause. But, the succeeding ones generally coincide with the natural evening paroxysm; especially in continued and remittent forms of fever. I speak, however, of the disease as manifested by unembarrassed Nature, or when she may be duly assisted by art. Misapplied remedies, and various other exciting causes, will be apt to affect the periodical law, especially where Nature is least recuperative, as in continued and remittent fevers. The regularity of the paroxysm is also influenced by local congestions and inflammations, and this, particularly, when exciting causes are in operation (§ 773). These considerations, independent of their practical bearing, refer to important problems in the philosophy of life and of disease.

The paroxysms of fever, therefore, observe a diurnal period; rarely taking place in the night.

768, *b*. The foregoing natural paroxysm extends its influences to all diseases, and influences, also, the operation of remedial agents.

769. If a paroxysm return two or three times, or two or three relapses take place at short intervals (as a few days, or perhaps weeks), the force of morbid habit is manifested; since in one case the paroxysms continue to return with greater obstinacy, and in the other relapses are more likely to follow, and this, often, for a great length of time (§ 535, &c., 768 *a*). Much, however, may be frequently due to supervening local congestions, which keep up the predisposition to fever, and operate, also, as exciting causes (§ 645, 665, 666, 870). Where the intervals are long, the return of the fever is not a relapse, but a new attack; though this is truer of continued than of intermittent or remittent fever. And this leads me to say, that any remote cause of fever is less apt to produce a relapse than to excite the disease in one who has not been before affected (§ 544, 550, 560, &c.).

770. It would be difficult to say why the paroxysms of fever are separated by definite intervals, and these intervals, too, remarkable for their variety as well as precision in the same form of fever. They show us at least, however, the absurdity of expounding disease by any of the laws or agencies that are known in the inorganic world. These definite intervals have given rise to several designations of the same form of fever; and according to the interval so is the *type*. We have nothing like this in inflammations (§ 712–722, 764 *e*).

771. In the continued form of fever, and in remittents, the paroxysms (or exacerbations, as they are then called) recur about once in

twenty-four hours; but the interval is more indefinite than with intermittents. In a majority of the cases of intermittent fever, the paroxysms are repeated at the end of twenty-four hours, and hence the name of *tertian*, or tertian type. The next most common are *quotidians*, or fever with daily paroxysms; each one taking place at the end of twenty-four hours. A third, and most fixed variety, is called the *quartan*, having a return of its paroxysms in seventy-two hours.

772, *a*. Sometimes there is a periodical difference in all the varieties, or types, of the intermittent, of four hours; and if, as now and then happens, the difference be greater, the fever is said to be *irregular*. These irregularities are commonly owing to local congestions, or other accidental influences, the removal of which will generally establish the more definite interval.

772, *b*. When the foregoing deviations occur, the paroxysms may either anticipate the usual hour, or be delayed beyond it; and it is a remarkable fact, and strikingly illustrates the law of vital habit (since it is inobedient to the influence of the natural paroxysm of health), that in such cases the paroxysms are apt to go on with the particular irregularity with which they began (§ 544, &c., 768 *a*).

772, *c*. Another remarkable fact connected with the intrinsic nature of the vital properties, and illustrative of the special institutions of organic life, relates also to the inequality of the foregoing intervals. That is to say, if the interval of tertian paroxysms, for example, deviates from forty-eight to forty-six hours, or, on the other hand, from forty-eight to fifty hours, the occurrence of the paroxysms will be growing earlier in the former case, and later in the latter. But this is not the most striking phenomenon attending these cases; for when the paroxysms, by their regular anticipation of the period of each last preceding paroxysm, approach the night, one paroxysm is often lost. This phenomenon, however, has its more obvious foundation, as the others have more obscurely, in the natural law of the body already mentioned (§ 768, *a*), since there is no inherent tendency in the system to induce a paroxysm during the night (§ 137 *b*, 149–152, 638).

773. The intermittent and remittent fever are often so nearly allied in pathology, that it is sometimes difficult to decide upon the type. Here the deviation from the regular form of the intermittent is clearly owing to the presence of venous congestions, or to inflammation; since the intermissions will become well defined as soon as those complications are removed (§ 758, 762, 768 *a*).

774. The natural duration of continued fever is about three weeks, rarely six. It varies with intermittents according to the particular type. Such is the power of vital habit (§ 544, &c.), that a tertian naturally occupies from three to four months; and this is one of the numerous instances in which the advantages of medicine are illustrated, and the philosophy of solidism established; since, as it respects the pathology, an emetic, or a dose of quinine (of no analogous virtues), may so alter the morbid properties as to place them at once in a condition to recover their natural state (§ 557 *a*, 904 *d*).

Much, however, of the prolongation of fever is often due to the local forms of disease which supervene on its progress, to errors in diet, fatigue, &c.

775. Opposed, also, to the humoral pathology, and all the physical hypotheses, is the occasional sudden termination of continued and in-

termittent fevers, in a state of health. This is generally preceded by a severe paroxysm, and the disease is ended at once (§ 557, *a*). The very violence of morbid action is attended by an alteration of the organic properties which enables them to take on the recuperative process; just as we sometimes see alcoholic stimulants overthrow acute inflammation, or the same conditions of fever (§ 756). Will the chemist or humoralist explain? Fothergill, Falconer, and others, supposed that the full and tense pulse which often supervenes on apoplexy depends upon a struggle which arises from an action of the *vires vitæ* to restore health. "I believe," says Fothergill, "it happens in most cases where there has been a temporary, or even momentary cessation of the animal powers."

Remote Causes of Fever.

776. I come next to the remote causes of fever, and to consider, also, yet farther, how the general pathological condition, as in inflammation, is liable to modifications by differences in the nature of the remote causes, and how, also, fever is influenced by coexisting inflammations and venous congestions; with a view to farther illustration of principles of various import.

777. The predisposing causes of idiopathic fever probably consist, in all cases, of the results of vegetable decay (§ 652, 653). The special type and modification of the fever are determined very greatly by the nature of the new combinations; though other influences may contribute (§ 650, 651, 758, 762, 773). The essential causes make their impression so profoundly, that the incubation goes on although the causes may have long ceased to operate; which is commonly different with inflammations (§ 711, &c.). The causes of fever are also distinguished by the peculiarity of so modifying the organic properties of certain parts by their direct action, that the entire system is sympathetically brought into a corresponding morbid state (§ 148, 657 *b*).

778. The predisposing causes of fever have been considered in all their other relations to the disease under that general division of pathology; their modus operandi, the nature of predisposition, the intervening periods, &c. (§ 148, 644, &c.).

779. The predisposing causes of fever are also causes of inflammation and venous congestion; and hence it is, in part, that fever rarely continues long without the appearance of one, or the other, or both conjointly, of these local affections. Or, the local may precede the constitutional disease, and become its *exciting* cause; or the former may exist without developing an attack of the latter, although the system be predisposed to the constitutional affection. Or, again, the explosion of the general malady is very apt to occasion a full development of the local conditions of disease in organs so predisposed. But, independently of this predisposition to local disease, it is the great tendency of febrile action to lay its foundation. The occurrence of these local affections modifies very variously the constitutional disease, and increases its force and obstinacy. The treatment, therefore, must turn greatly upon the local complications, and remain strictly antiphlogistic till they are removed or greatly subdued.

780. It may seem remarkable that diseases which are so considerably diverse in their pathological conditions as fever and inflammation should be produced by the same predisposing causes. But this only

shows that there are analogies among all diseases. All depend upon certain states of the properties of life; and as these properties can never be greatly diverted from their natural conditions, till life is at its ebb, there must be affinities among all morbid states. By considering, also, that the vital properties have various natural modifications in different parts, we come to understand how the predisposing causes of fever may simultaneously predispose particular organs to inflammation, or venous congestions (§ 133–152, 741 *b*, 767 *a*, 786, &c.). What I have said, also, in former sections (§ 662, 670, 675) as to the fluctuating state of the vital properties and functions during the progress of a febrile paroxysm may reflect light upon this subject of analogies.

Pathological Cause of Fever.

781. Coming to the pathology of fever, morbid anatomy yields no assistance, and proves that our conclusions as to the essential nature of disease must be mainly derived from its phenomena during life (§ 695, &c.). It is therefore not remarkable that they who look for the philosophy of disease to its direct manifestations should alone distinguish idiopathic fever from inflammation (§ 695, &c., 712–722, 757, 759, 764, 770).

782. Next to the proximate cause of inflammation, no question in medicine has occasioned more speculation than that of fever. The humoral pathology has been at the foundation of many hypotheses, and others have risen upon some supposed change in the organization of the parts. These were the ancient, and are now the prevailing doctrines.

783. In no form of fever do the symptoms denote an absolute unvarying affection of any organ; but, on the contrary, the greatest variety occurs as to the force of the disease in different parts. These contingencies have suggested the minor designations, as stated in section 758 (§ 134, 138, 142, 143, &c.).

784, *a*. Fever being a disease of the whole body, and constantly liable to complications with local inflammations and venous congestions, it is particularly important that all the attendant symptoms should become elements in forming our conclusions as to the nature and force of the disease, both in a general and local sense, and that our prescriptions should be determined by the aggregate weight of the phenomena (§ 675). Vicissitudes may be also hourly occurring in different parts, embarrassing to the judgment of the practitioner, and demanding its highest exercise (§ 675, 685, 686, 857).

784, *b*. Owing to the universality of the disease, and the general coincidence in its pathological character, remedial agents, when applied before morbid habit has taken possession, or local inflammations have supervened, will stretch their influence over the universal body, and may institute every where those pathological changes which are capable of a progressive march to their ultimate termination in health (§ 148–152, 487, 535, &c., 557, 672, 854, 893, &c.).

785. It is the triumph of morbid anatomy that it lays open to the senses the tangible products of inflammation; while it seizes upon what an observation of Nature had already determined as to the pathology of the disease. The great family of fevers shall sustain this position of the vitalist, since here nothing is seen, nothing tangible, after life has become extinct. The knife of the anatomist goes down

to the smallest fibre, and the aid of the eye-glass is summoned in vain. And yet do we know about as much of the pathology of fever, for practical purposes, as of inflammation, and the treatment of one is as well determined as of the other (§ 234). This has been inferred from the vital phenomena of both diseases, and from an observation of the effects of remedies. These phenomena are not less multifarious in fever than in inflammation; and so far as sensible changes attend the immediate instruments of disease, there is more to be seen in febrile than in inflammatory diseases. In both, there is commonly an increased volume of blood circulating in the capillaries; but there is also, as a common element of fever, a primary contraction of those vessels. What I have now said is the test between organic philosophy and morbid anatomy.

And how is it with the signs which denote the essential pathology? We have seen that the facts are equally clear in both diseases, that there is an exaltation of irritability and mobility from the time of their invasion (§ 743, 744, &c.). But that is all we can learn of the particular changes which they undergo in either affection, and that is only a minor part of the disease. The organic properties and functions have also sustained a change *in kind*, which is likewise known by the phenomena. It is that change which constitutes, essentially, the diseases, respectively, and which distinguishes one from the other (§ 177–181). The phenomena, however, do not indicate the nature of this essential change; but what they disclose as to the exaltation of irritability and mobility, in connection with their more indefinite suggestions, and with experimental observation, enable us to institute all the pathological and therapeutical principles that are necessary or useful in practice. The rest is concealed, because it would be useless for man to know it.

The cold stage, or invasion of fever, when morbid action is most profound, is marked, it is true, by an apparent debility of the living powers; so much so, indeed, that it may be difficult to show that this universal opinion is erroneous. In a former section, however, I have attempted it (§ 743). Its practical importance cannot be too highly appreciated, since it deters the practitioner from the use of the lancet, or leads him to that of stimulants; especially in congestive fevers (§ 961, &c.). The error has proceeded, in part, from the very fact which evinces an exalted state of irritability and mobility,—the tonic contraction of the capillary vessels during the cold stage. The embarrassed action of the heart, diminished circulation, sympathetic influences of venous congestions, the partial loss of control over the voluntary muscles, or indisposition of the will to act, and the want of a proper estimate of the properties of life, and of the morbid changes to which they are liable, have contributed their share to this mistaken view of the pathology of fever. Nothing, however, has done so much toward the doctrine of "debility," and the stimulant treatment, as the impaired energy of the will over the voluntary muscles, which arises from the venous congestions that are associated with fever (§ 467 *c*, 487, 488½). I shall therefore proceed next to the subject of Congestion.

VENOUS CONGESTION.

786. The pathology of venous congestion, its treatment, &c., form an extensive Essay in the Medical and Physiological Commentaries.

For all that relates to the pathology of that disease, as well as of varix, and for an exposure of the errors of former doctrines, and, indeed, for most that is essentially important in that Essay, I claim the merit of an exclusive originality.

787. The conclusions at which I have arrived, if founded in nature, are among the most important in practical and theoretical medicine; since the conditions which obtain in venous congestion often demand an energetic practice, reveal the true cause of the extensive mortality which has resulted from the stimulant treatment of fevers, and enforce the admission of some of the most important doctrines in physiology (§ 710, *b*). The relation, for example, of the pathology of venous congestion to the philosophy of the circulation of the blood, &c., illustrates the vital character, and establishes the elements of that complex function (§ 384–391).

788. During the last century, the enlarged state of the veins, which forms the prominent characteristic of venous congestion, attracted the attention of several writers, who ascribed a malign influence to the enlargement, though they regarded it merely as a mechanical phenomenon. From that time, till a recent period, this state of the veins was lost sight of entirely, notwithstanding it contributes, more than the recognized forms of inflammation, to the mortality of the human race. The neglect of this disease in our own times probably arises from the prevailing disposition to interpret organic phenomena, whether healthy or morbid, upon chemical and mechanical principles.

789. The foregoing enlargement of the veins is an essential condition of the disease, though of minor importance. This enlargement has been universally referred to an obstruction of the current of venous blood, or to a partial relaxation of the coats of the veins and a stagnation of blood within them. It has been also as universally supposed that all the evil results of this disease are owing to the accumulated or stagnated blood, while it is in the highest degree probable that neither the enlargement of the veins, nor the increased volume of blood within them, is productive of a single morbid phenomenon (§ 748).

790, *a*. The enlargements of veins which are produced by ligatures, hanging, reflux of blood, and as presented in the "circuitous circulation" occasioned by the pressure of tumors or obliteration of the trunk of a vein, are in no respect instances of venous congestion, although they are generally adduced as the most palpable examples of that disease. Nevertheless, the stimulus of distension arising from pressure on a vein may give rise to the sub-acute disease which constitutes essentially congestion, varix, and venous hypertrophy; as set forth in my former Essay.

Four mechanical hypotheses have been surmised, to meet the exigencies of all cases. One of them supposes, that, during the cold stage of fever, the blood being determined from the centre to the

circumference, accumulates about the heart, and then regurgitates throughout the venous system of the internal organs. A second is similar in principle. It supposes that, at other times, the accumulation results from a simply diminished energy of the *vis a tergo*, which is inadequate to the maintenance of a free circulation, and that an accumulation of blood takes place in the veins as a consequence. A third hypothesis assumes that an embarrassed circulation takes place in the lungs, by which an obstruction is constituted to a return of blood to the heart, when, also, as a farther consequence, the blood accumulates in the veins of other parts, particularly the head. The fourth hypothesis is universal, but peculiar to a few. It imagines that venous congestions in all parts are owing to obstructions occasioned by hepatic disease.

I have shown that the objections to all the foregoing suppositions are numerous and conclusive. In respect to those of a general nature, which are mostly applicable, I may now say that it is obvious that the blood would accumulate principally about the right cavities of the heart alone, and not in the veins of distant organs. Or, should a reflux happen, it should be coextensive and equal in the veins of all parts at equal distances from the heart. On the contrary, however, venous congestion is limited to particular parts, often to one organ, which may be, also, distant from the heart or supposed centre of obstruction. It is often, for example, the brain only that is congested; where, too, accumulations of blood, unless from disease of the venous parietes, would be prevented by gravitation alone. Again, also, were there any foundation for these hypotheses, the liver, stomach, kidneys, lungs, &c., should always be congested whenever the brain is the seat of the supposed reflux of blood. It is also obvious that, the moment an equilibrium is restored to the general circulation, as in bloodletting, the volume of blood should be equally reduced in the veins of all parts. Contrary to this, however, the veins of some particular organ or organs often continue in a state of great enlargement, as in the brain, &c.; while the central accumulation of blood, the supposed cause, is now completely removed.

790, *b*. So indefinite has been the pathology of venous congestion, that injuries attendant on falls, and those prostrated states that are induced by the shock of surgical operations, have been regarded as identical with profound congestion; and this even by so distinguished and able an observer as Dr. Armstrong. This great error in theory may explain his commendation of stimulants in aggravated forms of congestive fever, and is probably one of the causes which have led to their more indiscriminate use in less prostrating conditions of the disease (§ 970).

791. To arrive at the true pathology of venous congestion, as well as to ascertain the powers which circulate the blood, it was one of my primary objects to show that the state of the circulation in congested veins is exactly the reverse of the foregoing supposition (§ 790); that is to say, that the veins are in a state of active dilatation, and that the blood circulates freely within them. (See *Comm.*, vol. ii. Also, § 382–394.)

792. I have shown, also, that the veins are susceptible of active dilatation in their natural state from the local irritation of stimulants; and that it is owing, primarily, to this action of the veins that they

swell when the hand is immersed in warm water or exposed to a fire. From these premises, I passed on to a demonstration that the veins possess an exquisite relation to the communicating arteries, of a sympathetic nature, and by which they dilate actively in obedience to the action which exists in the communicating arteries, and the quantities of blood which may be transmitted.

I endeavored to show, also, that when the veins become inflamed, as in acute phlebitis, or in the sub-acute state of venous congestion, the inflammation of their coats acts as a stimulant, and thus occasions an active dilatation.

793. Whatever, therefore, will produce any degree of inflammation in the venous parietes, will be a remote cause of dilatation; and, although the phenomenon depend upon that physiological constitution of the veins which occasions their active dilatation when increased quantities of blood are transmitted from the arteries, or when they are irritated by simple stimuli (§ 387), there is a wide difference in the proximate cause of the morbid and the natural phenomenon. In the latter case there is simply an obedience to natural influences, and the phenomenon is therefore transient; in the former, the influences are morbid, and the organic properties altered from their healthy standard, and the dilatation, therefore, is also cotemporaneous with the disease, or until the vein becomes disorganized, as in acute phlebitis. In the natural state there is also an increased volume of blood constantly transmitted to the veins; in the morbid the increased volume depends upon the enlargement of the veins. And yet the morbid dilatation has the physiological constitution for its foundation.

The following example shows the operation of the natural principle. "Cooks," says Sir B. Brodie, "are subject to varicose veins. Why? If you put one hand into warm water, and the other into cold, you know that the veins of the former become dilated, and that those of the latter will contract."

This is a clear illustration of the physiological constitution of the veins, both as to active dilatation and contraction. But it goes no farther. The dilatation is the result of the operation of a healthy vital stimulus, and depends, in part, upon a constantly-increased volume of blood which is transmitted from the arteries, as set forth in section 387. In varix there is no such increased volume transmitted, nor in phlebitis, nor in venous congestion. The dilatation is also permanent in the latter cases, while in that of the cook it subsides as soon as the stimulus of heat is withdrawn. The illustration is, indeed, a contradiction of the intended philosophy, since cooks are not subject to varicose affections in their arms, which are alone, though constantly, exposed to hot water. And so of the glass-blower. It is nothing more than the phenomenon which proceeds from exercise, or febrile action, or even from the common forms of inflammation; though slightly modified in these morbid states of action. The example serves to confirm, also, what I have taught as to the physiological relations between the arteries and veins, and the instrumentality of a great principle in the circulation of the blood.

The assumed analogy to varix in the foregoing example is a part of the common mistake of confounding the physical with the vital laws, and shows the untenable nature of all such positions. We relax dry, dead matter by soaking it in warm water. The water pen-

etrates the substance; and this whether warm or cold. But what would be the effect upon the cook if she take the hand from the warm water and place it with the other in the cold water?

794. The venous tissue is composed of three coats; the inner, which resembles considerably a serous membrane, the middle, which possesses longitudinal fibres, and the external or cellular coat.

The inflammation is seated mostly in the inner coat. Contraction and dilatation are effected by the fibres of the middle coat; which, being longitudinal, are capable of producing contraction or dilatation with rapidity and uniformity over a great extent. This natural provision was necessary to the purposes of venous circulation, and to accommodate the diameters or capacity of the veins to the suddenly and constantly varying proportions of blood transmitted to them from the arteries. Circulation could not be performed without it; since, if the dilatation of the veins were effected by the supposed mechanical distension of the blood when increased volumes are determined upon them by the arteries, the physical resistance of the veins would impede the transmission, and the subsequent progress of the blood. There would then be a want of harmony between the arteries and veins, which would constitute a fundamental defect in organization. Nay, more; this harmony reaches, also, to special modifications of the organic properties of the venous tissue, by which the veins are rendered sensitive to the varying states of the capillary arteries, and to impressions arising from the varying quantities of transmitted blood (§ 133, &c., 385).

795, *a*. Now, it is in the foregoing peculiar organization of the veins, and the special modifications of their vital properties, that all the remarkable phenomena of acute phlebitis and venous congestion have their foundation. The veins dilate actively when inflamed, because such is their natural function when impressed by stimuli, especially their natural stimulus, the blood. Their dilatation is permanent in inflammation, as that affection operates as a permanent stimulus; and irritability is permanently increased, by which the blood has, also, a preternatural effect (§ 143, &c.).

795, *b*. From the exquisite development of their organic properties, the veins are extremely liable to inflammation; especially that subacute form which constitutes venous congestion. And whether their inflammations exist in the form of acute phlebitis, varix, or venous congestion, it is always diffuse, extending rapidly over the venous tissue, and liable, in all its forms, especially of phlebitis and congestion, to give rise to great constitutional disturbances. The diffuse nature of inflammation is partly owing to the natural principle by which the venous tissue has an associated action over an extensive surface; and all the local and constitutional phenomena may be traced to the peculiar vital constitution of the veins (§ 151, &c.).

Turning, however, to the arterial system, we find all things quite the reverse, and referable to the natural vital constitution of those vessels (§ 149, &c.). The arterial tissue is very little liable to inflammation, the disease is always very circumscribed, and produces but little, or no constitutional effect (§ 140, 526 *a*).

796. It was an important object in my Essay on Venous Congestion to establish satisfactory analogies between acute phlebitis and venous congestion, and I extended the analogies to varix and venous

hypertrophy; and in so doing, as well as by the specific facts, demonstrated the inflammatory nature of these last affections. The several conditions were thus brought to illustrate and confirm the common nature of their pathological cause. Nor was the necessity overlooked of showing the fallacy of the universal doctrine of the dependence of varix upon local obstructions to the venous circulation and stagnation of blood, nor of applying to practical uses the true pathology of varix (§ 350¼). It was thus shown how it happens that tying, or dividing, varicose veins, is so often followed by active phlebitis.

Besides its never having been shown that any obstructing cause exists either in venous congestion, or in the early stages of varix, if any stagnation of blood arose from other causes, the valves of the veins should be closed, and a knotted appearance presented at the several points. Such, indeed, had always been the supposition in relation to the valves, till I proved it otherwise. While the blood circulates, the valves are necessarily open (§ 391).

797. Taking the most simple and subdued form of venous inflammation, and in its most local sense, we have a type of the whole by which we may ascend progressively upward till we reach the strongly-marked conditions of phlebitis, without losing a hold upon many striking analogies which assure us that the common feature is imparted by venous inflammation. When constitutional influences may not obtain, as in the ordinary conditions of varix, there are still present the dilatation of the veins, their long-continued, unembarrassed circulation, their ultimate disorganization, pain, soreness, liability to active phlebitis, &c., to establish the intimate relationship of varix to the highest grades of venous inflammation, and to throw a broad light over the common family, however they may be removed in degrees of consanguinity.

798. It is also an important practical fact, as well as proof of the physiological doctrine of venous congestion, that this affection often springs up in quick succession in different organs, and often manifestly as sympathetic results of each other (§ 525, *a*). The same is also partially true of active phlebitis. Apoplexies are often remotely owing either to irritation of the stomach, or to venous congestions of the liver. On dissection, we find in most of the cases a state of venous engorgement in the brain, which has been excited sympathetically by one of the foregoing causes. It is especially to hepatic congestion, connected with peculiar influences of external predisposing causes, and the law of sympathy which predominates in the venous tissue (§ 387), that we must ascribe the epidemic apoplexies which have been described by numerous writers from Hippocrates to our own times. And how absurd would be the conjecture that in such apoplexies there happens an epidemic mechanical obstruction to the venous circulation of the brain, and where, too, gravitation would prevent all accumulations of venous blood, were it not for the active, morbid dilatation of the veins!

799. My demonstration, also, of the essential contribution of the derivative or suction power of the heart to venous circulation brings into view another principle which must tend powerfully to prevent all accumulations of blood in the veins.—(*Essay in Comm.* Also, § 388–390.)

800. Passing over a multitude of facts which I formerly embra

ced in the foregoing illustrative proof of the inflammatory nature of venous congestion, and varix, I may now appeal to morbid anatomy for a tangible demonstration of my conclusions. But this ground is too extensive and circumstantial for the objects of the present work; and it has been most amply explored in my former Essay. It is worthy of remark, however, that the blood often gravitates from congested veins of the liver after death.

801, *a*. Let us, therefore, attend next to a more practical demonstration, which will be again resumed under the Philosophy of the operation of loss of blood; namely, the appropriate treatment of venous congestion, in its simple forms, and as complicated with idiopathic fever. There is no practical question of greater moment, none more likely to be decided by theoretical principles, and none where the therapeutical facts settle more conclusively the nature of the disease, and the principles which should guide the treatment.

801, *b*. The method of cure had been either empyrical, or without a sound principle to guide it, till my Essay was published. So far as the mechanical hypothesis has had its sway, it has led to nothing but error, suffering, and death; since, upon that ground, stimulants have been the remedies.

Nevertheless, experience has led some of the soundest minds, as it has many in regard to the humoral pathology in its broad application, to disregard the dictates of hypothesis, and to depend upon bloodletting and other antiphlogistic means; and the result has proved that they are the only successful means. But there was little of this practice till the time of Armstrong, and even this philosopher yielded to the mechanical doctrine in those intense forms of the disease where loss of blood was most imperatively demanded (§ 4, 960, 961, 964, 1005).

Now, therefore, antiphlogistic means being the remedies for inflammation of other tissues, and stimulants, as in such inflammations, being pernicious in venous congestions, they concur with all other facts in establishing the inflammatory nature of this disease.

801, *c*. By the guide of the pathology and principles which I have indicated, and as shown by the results of the best and the worst experience, we apply ourselves to the work of cure with an intelligible object before us; nor are we harassed by doubts, nor fluctuate from experiment to experiment (§ 960, 1005). There is a specific object in contemplation, the only principal one to which our treatment should ever refer (§ 667, &c.), and we pursue it with steadiness of purpose, and without the alarm or those imputations of imbecility to a noble art which flow from the mechanical doctrine, with its associated visions of *debility*. We regard the prostrated muscular strength as constituting much of what otherwise seems a state of universal weakness (§ 487 *h*, 569, 743), and look, as in all other cases, with the calmness of an enlightened understanding, upon an insidious and powerful foe, since we know his ambush and his strength, and our own means of circumvention and defeat.

802. As to the incipient seat of venous congestion, I shall only now say, that farther observation has sustained the opinion which I expressed, and endeavored to enforce, in the *Commentaries*, that there is "much ground for believing that the inflammatory action begins in the capillary veins, and that it is subsequently propagated to their trunks."

Many grounds are set forth for the conclusion, some of which were of the nature of principles; such as the extent in which the venous system of organs is generally and simultaneously involved, &c. This also corresponds with what I have said of the natural function of these vessels in relation to the varying proportion of transmitted blood.

When the larger veins are the seat alone of accumulated blood, they are commonly isolated, as in varix. Nor does venous congestion affect the largest series; but it is commonly limited to some complex vital organ, where we are certain that the capillary veins are more highly endowed with the properties of life than in parts which are less instrumental in the great organic processes, and where remote causes, external and internal, may therefore operate with greater intensity, or any general derangement of the organ may develop in the venous capillaries the supposed morbid condition. The terminating series of the arterial system are the instruments of all the great vital actions, and of all diseases,—of venous congestion itself. Analogy, therefore, as well as the general office of the veins, and their anatomical and functional alliance to the terminating series of arterial vessels, show us that the organic properties of veins are more strongly pronounced in the venous capillaries than in the venous trunks. And yet they may be so modified that inflammation may run higher in the trunks than in the capillaries (§ 134, 387, 526 *a*).

803. Venous congestion often passes rapidly into inflammation of other tissues with which the congested veins may be associated; and both forms of the disease frequently exist together in the same organ. This remarkable fact of the ready passage of venous congestion into inflammation of other associate tissues grows out of the vital relations between the veins and arteries (§ 387). The mode of propagation, therefore, is by continuous or by remote sympathy (§ 498–500). The presence of inflammation in the coats of the veins operates either directly or indirectly as a stimulus upon the communicating arteries, through the foregoing natural relations (§ 802), and thus becomes a sympathetic cause of inflammation in some other associate tissue. The nature of the irritation is strongly manifested in the violent pulsations of the abdominal aorta, and of the cœliac and carotid arteries, in hepatic and cerebral congestion; and, I may add, that this phenomenon alone would establish the vital nature of the whole assemblage of movements and results.

804. But, while the foregoing morbid action is taking place in tissues associated with the congested veins, an abatement of the congestion or venous inflammation is simultaneously going forward. This harmonious process involves, also, another beautiful exemplification of the laws of sympathy. As soon as the supposed influence is established upon the capillary arteries of the surrounding tissues, a reaction of sympathy takes place in the veins, by which the morbid state is overcome (§ 143 *c*, 152, 524 *c*, 528, 657, 660, 905). Their contraction then follows, as a consequence, and "the balance of the circulation," as it is called by the mechanical theorists, is more or less restored. This salutary reacting sympathy which arises from the supervening diseases is a common phenomenon. Pulmonary affections, for example, will spring up, sympathetically, from gastric disease, and simultaneously operate as a relief to the stomach. A part of this great and universal law is manifested by the operation of blisters, and sometimes,

when the artificial disease subsides, its abatement accelerates the decline of the natural affection, and thus exemplifies the law in its compound aspect (§ 733 *e*, 905).

Inflammation of other tissues is also an exciting cause of venous congestion, and here, too, the primary affection is apt to subside when the sympathetic one has taken place; the philosophy being the same as in the preceding case.

Nevertheless, it will be seen, from the nature of the interchanges now stated, that venous congestion and inflammation of other associate tissues should often coexist.

805. With the farther object of illustrating the pathology of venous congestion, as, also, to ascertain the pathology of spontaneous hemorrhage, I have gone into a critical inquiry relative to the latter subject in two Essays embraced in the *Commentaries*, one of which is devoted to that investigation (vol. i., p. 371–384; vol. ii., p. 546–566). The subject involves some physiological and therapeutical principles of great moment; and so far as I have shown the general dependence of hemorrhage upon venous congestion, it goes with my other facts in establishing the inflammatory nature of the disease. As a preliminary step, I demonstrated by the observations of mechanical theorists, that the prevailing physical *rationale* is contradicted by their own facts; that it is very rare that ruptured vessels have been detected by the microscope, and that no vessels admit the transudation of their fluids till putrefaction has opened the way. I shall now only add, that I have variously shown that capillary hemorrhage is not only the result of a vital process, but is analogous, as had been supposed by Hunter, to that of secretion. Prominent examples occur in purpura hemorrhagica, in petechial fevers, in sanguineous apoplexy, hæmoptysis, &c.

The effusion of blood is the result of a salutary effort of nature to relieve the venous inflammation (§ 732). The quantities of blood which are often poured out in this condition of disease, not only with safety but with relief, are perfectly astonishing, and such as would be fatal if imitated by art. We may, however, well take a lesson from nature as to this her antiphlogistic treatment of venous congestions, and pause over the administration of stimulants to revive the energies of nature when prostrated by an overwhelming load of venous inflammation, for the relief of which nature often snatches the cure from the hand of art, and astonishes the stimulant practitioner by a stupendous and successful discharge of blood (§ 812, 1018, 1019).

806. The influences of venous inflammation, in all its degrees, are very different from inflammation of other tissues (§ 140). The general circulation, for instance, is apt to be much excited in common inflammations; but in acute phlebitis, and in venous congestion, the powers of the system are very liable to be prostrated, and along with them the general circulation. This is generally true when either form of the disease exists in its greatest intensity; and the phenomena of excitement obtain, more or less, when these forms of venous inflammation are less violent, or when on the decline.

Its remote sympathetic influences, whether the disease be acute or sub-acute, are of a compound nature; partly the exciting influences of inflammation when affecting other tissues, and partly the depressing effects which are peculiar to morbid changes in the venous tissue.

These are the most visible results, though more profound changes take place. The predominance of these two manifest influences is generally on the side of the depressing effect, in the stages of full development; but, in what may be called the chronic state of venous congestion, the exciting and depressing tendencies seem more nearly balanced. An exception, however, should be made in respect to venous congestion of the brain, where the usual exciting influences of inflammation are commonly in the ascendant (§ 686 *b*, 974 *c*, 975). It frequently happens that a very decided hardness, incompressibility, and considerable fullness of pulse attend the chronic forms of hepatic congestion, and that there will be little other apparent constitutional disturbance, excepting as the stomach performs its office imperfectly, the bowels more or less torpid, &c., and that these cases may suddenly eventuate in a very aggravated form; especially if miasmatic fever happen to supervene. The character of the pulse then undergoes a very striking change; becomes small, accelerated, loses much of its hardness and incompressibility (§ 686 *b*, 688 *d*, *e*). A chronic state of hepatic congestion is often the forerunner of miasmatic fever, and one of its exciting causes; the local predisposition having been formed by the predisposing cause of the general malady (§ 665, 813).

807. The local phenomena, also, are apt to be obscure in all gradations of venous inflammation; and it is no unusual event for uterine phlebitis to terminate fatally without its presence having been suspected; till a post-mortem examination has revealed a disorganized state of the uterine and iliac veins, attended with purulent matter within the vessels. And, although it is not my purpose to enter into a detail of symptoms beyond what may be necessary to illustrate the pathology of venous congestion, and the general principles which I have in view (§ 800, *b*), it is still worthy of the practical remark, and as showing, also, the special constitution of the venous tissue, that its inflammations of every degree are apt to be unattended with much pain, or tenderness on pressure; though most so in the form of varix, which is sometimes very painful, and often tender (§ 725, *b*). An absence of those common phenomena of inflammation of other tissues, and perhaps only a subdued state of some other of its striking symptoms, not unfrequently betray the unwary into a false security, or beguile him into the fatal belief that "debility" is the worst attendant.

808. Upon my theory, therefore, of the pathology of venous congestion, we see more and more an admirable concurrence between the morbid phenomena of that affection and the natural physiological manifestations of the venous system; and we arrive through the physiological data at a ready interpretation of the most difficult problems in venous congestion. By these data we are enabled to discover, also, why the veins of the external parts of the body are not, like those of the internal organs, subject to congestion, but rather to varix; and why, again, an acute inflammation of a large internal vein is often limited to a point of divergence (§ 133–152, 526, 576 *d*, 578 *d*, 579 *b*, 721, 722, 794, 795).

809. It is owing especially to the foregoing peculiarities of venous inflammation, that when complicated, either in its form of acute phlebitis or venous congestion, with idiopathic fever, it greatly modifies the phenomena of that disease; rendering it insidious, obstinate, and fatal (§ 651, 652, 722 *c*). It is always an attendant of the plague,

yellow fever, typhus, cholera asphyxia, "black death," &c., and imparts to them much of their peculiarities, severity, and danger.

810. Venous congestion and acute phlebitis not only steal their march in ambush (§ 807), but often throw a mask over constitutional fever, or present their own characteristics as the prominent phenomena. Hence it is that when venous inflammation is artificially excited by mechanical injuries of the veins, or by irritating injections, the results are said to resemble those of typhus, or yellow fever. It was this illusion, as well as a radical defect in his physiological views, and practical observations, which betrayed Magendie into the experimental fallacies recorded in a foregoing section (§ 744).

It will be also observed that the experiments go to prove the dependence of many of the phenomena of typhus and yellow fever upon the attending venous congestions.

811. The foregoing modifying influence of venous congestion upon idiopathic fever (§ 688 *dd*, 806, 810, 961, &c.) is one of the many clear demonstrations of the modifying effects of local disease upon the vital states of the whole system, illustrative of the manner in which it may bring all parts into harmonious relation with any changes which such local disease may effect in the blood, and which would otherwise prove morbific (§ 847, *g*). It shows, also, how the entire body may be rendered susceptible, through morbific influences, to the action of remedial agents which might be otherwise inert, and how, when those agents exert salutary effects upon the various parts that may be partially influenced by some local malady, the morbidly sympathizing parts may then become reacting sources of salutary impressions upon the more absolute seat of disease (§ 143, 149–152, 514 *h*, 638, 804. Also, *Med. and Phys. Comm.*, vol. i., p. 649, 653–655, &c.).

The sympathetic influences of venous inflammation being of a mixed character (§ 806), are extended, also, over the phenomena of any coexisting membranous inflammation, as well as of idiopathic fever; thus presenting still farther, in their delicate shades as well as prominent characteristics, the complex results of different forms of disease, whether existing independently or in connection with each other, or offering a striking illustration of the natural modification of the properties of life in the different tissues and organs, of the manner in which morbid changes in any common disease correspond in peculiarities with the natural peculiarities of the vital properties of the tissue, and showing how the sympathetic influences exerted on remote parts correspond with the peculiar conditions now stated (§ 133–151, 191, 577, 578). It is also worthy of remark, that where venous congestion is complicated with inflammation of other tissues, it is apt to lessen the hardness and force of the pulse, and to modify the other symptoms which are usually attendant on the recognized form of inflammation. In congestive pneumonia, and epidemic erysipelas, for example, it so far disguises the usual phenomena of the associated inflammation, that practitioners are constantly betrayed into the fatal use of tonics and stimulants. These associated conditions supply, also, a good exemplification of the tendency of venous inflammation to maintain the pulse within a limited degree of that hardness and incompressibility which are often very strongly pronounced in inflammations of other tissues (§ 814).

812. Examples of independent, isolated forms of venous conges-

tion are constantly seen in the brain, especially of children and apoplectic subjects, in the liver, &c. (§ 800, *a*). But the most prominent instance occurs in purpura hemorrhagica, where all its phenomena may be studied, and where its inflammatory nature may be fully ascertained. Here there is no complication with fever, or with inflammation of other tissues, but the disease is constituted by very extensive congestion of the veins (805).

813, *a*. Venous inflammation, in the form of congestion, is occasioned, more frequently than inflammation of other tissues, by the predisposing causes of idiopathic fever (§ 644, &c., 742, &c., 776, &c.). Congestive fevers and local congestions prevail, therefore, at the same time and places. Both may also prove exciting causes of each other (§ 712, 777, &c.). The local affection may exist many weeks, grow into a state of intensity without being suspected (§ 807), and finally give rise to an explosion of fever, which, from the mildness of the predisposition, may not have happened but for the exciting influences of the local disease. The fever which ensues, though not a sympathetic, but an independent disease, aggravates the local congestion, and gives greater intensity to its symptoms; though both conditions may coexist for some time in great force and obstinacy without any prominent or alarming symptom. These cases are not uncommon, nor is it a rare circumstance, in such instances, for practitioners in good repute to stand appalled over a lifeless body where they had only a few hours before predicted an early convalescence; and if the morbid anatomist be summoned to the scene of disappointment, chagrin, and distress, he seeks in vain for his *post-mortem pathology*, and pronounces a malediction upon Nature, or upon the imperfections of science, or upon the imbecilities of art (§ 695, &c.). Medical philosophy is a metaphysical subtlety, and it were a thousand times better to confess our ignorance than to give up our senses.

813, *b*. Since, therefore, miasmata are so extensively the cause of venous congestion, it is important to consider that its exact pathological character will depend, cæteris paribus, like that of fever, upon the exact nature of the miasma (§ 653). Hence, also, the constitutional modifications of fever by venous congestions will be more or less determined by the exact pathology of the venous disease, as well as by the general effect upon the system of the miasmatic agent (§ 644, &c., 722 *c*).

814. The considerations which have been now made enable us to understand the sources of those numerous modifications which distinguish the different species of fever, and aid, especially, our comprehension of their connections with venous congestion, and the various modifying influences of this disease upon the constitutional affection. Depending greatly on the specific nature of their predisposing causes, the local, as well as the constitutional changes, being imbued in the several cases with the specific influence of these causes, and the general characteristics being determined, for the most part, by the constitutional affection, the incidental venous congestions impart yet another general resemblance among the congestive fevers; varying the whole from their simple type, and often more or less confounding the specific phenomena under a common aspect (§ 811).

It is upon principles which I have now, and at other times stated, that we may understand why the typhus of one country, or of one

season, has been, under equal circumstances of treatment, varied in its phenomena from that of another; why epidemic scarlatina and measles are more fatal than the simply contagious; epidemic erysipelas more so than sporadic; why the intermittents of Africa are more pernicious than those of other countries.

815. When venous congestion so far disguises the attributes of idiopathic fever as to present the constitutional phenomena of venous inflammation, there is no condition of disease which demands more imperatively enlarged views in pathology, a deeper scrutiny of symptoms, or greater moral firmness for its appropriate treatment. If danger be seen, it appals the timid, and prostrated muscular strength urges him to the fatal use of stimulants (§ 487, 488½, 569). Under these fearful, but common conditions, the presence of well-marked inflammation of other tissues contributes to the safety of the patient. Such inflammations, however undesirable in other aspects, tend to counteract, for awhile, the depressing influence of venous inflammation, to lull the imagination, which sees nothing but "debility," or "putrefaction," in the prostrated state of the circulation and of muscular action, and in itself sustains the powers of life under the influence of depletive remedies, which alone can cure; and gives the last remaining hope which may be inspired by the unaided *vis medicatrix*, but which may be speedily extinguished by tonics and stimulants (§ 662 *b*, 675, 686).

816, *a*. Venous congestion, being mostly occasioned by miasmata, prevails in its local form simultaneously with congestive fevers, and independently of any apparent predisposition to the latter. In this simple condition the disease is most apt to affect the abdominal organs. Nevertheless, it is evident in many of these cases, that the system is also imbued with a predisposition to fever (§ 666). In a still more simple form it is common in cities; particularly south of the latitude of forty degrees. It seems then dependent, also, upon malarious causes; and, although it sometimes occurs epidemically in such places, especially among children, there may be a general absence of fever. These places, however, are commonly within the range of congestive fevers, but where the intensity of the predisposing causes is kept down, or the causes otherwise modified by the hand of art, or by local situation, &c.

816, *b*. Other causes of malign influence may be transiently noticed. The disease, for example, is generally an accompaniment of severe forms of scarlet fever, appearing then mostly in the liver and intestinal canal; when it is also badly modified by the predisposing cause of the more specific affection. Again, it often springs up as a sequel of scarlet fever; when it is also imbued with the lingering influences of that complaint, and presents obstinate and difficult problems for the practitioner. It is still the digestive organs that suffer its invasion; and now it not unfrequently leads to inflammatory affections of the peritoneum, or of the cellular tissue of the surface, which ends in dropsical effusions; or, as when coexisting with scarlatina, glandular swellings may suddenly supervene about the neck. This is especially true if the intestinal canal be often subjected to the irritation of mercurials, which are apt to be of a peculiarly morbific nature in scarlatina (§ 589, *l*). Gastric irritations in childhood are common causes of hepatic and cerebral congestions; and in many adults there is a constitutional predisposition to cerebral congestion which is

apt to terminate in sanguineous apoplexy. Various kinds of poisons, animal and vegetable, healthy and morbid, give rise to venous congestions; each one imparting some peculiar shade of difference to the affection (§ 721, 722). Such is the case with the narcotic poisons, alcohol (in delirium tremens), hydrocyanic acid, the poison of dissection wounds, the wourari, &c. (§ 662, *c*).

All the foregoing causes, excepting miasmata, produce the local forms of venous congestion; which is therefore never complicated with idiopathic fever when proceeding from those causes (§ 653).

817. Looking back upon the attributes, the causes, the constitutional effects, and the morbid anatomy, of venous congestion, and considering what is yet to be said of its treatment (§ 961, &c.), we find a great amount of proof in favor of the vital doctrine which I have propounded as to the pathology of this disease. As in inflammations of other tissues, the causes are such as make their impressions upon the properties of life. We see, also, in like manner, even a greater variety of modifications of the phenomena, corresponding, also, with the special nature of the predisposing causes. We see the disease influenced by peculiarities of climate, habits, constitution, age, &c., and constantly arising with or without fever in some places, while it is rare in others. It affects the robust far more frequently than the weak; high livers, the sanguine, and especially tipplers, more than the temperate and other constitutions. We see it slaying the morbid anatomist, while its remote cause has been concealed in a wound which no microscope can discover. We see it springing up in the brain in obedience to the specific relations of many agents to that organ; narcotic poisons, alcohol, prussic acid, carbonic acid gas, &c. We see it coexisting with affections of a distinctly inflammatory character, as measles, small-pox, scarlatina, &c., always increasing their violence, and adding, according to the nature of the principal disease, to their fatality, as when complicated with idiopathic fever. Or, if it supervene on common derangements of other parts, those maladies are such as predispose to inflammation of other tissues. Nor has morbid anatomy detected a cause of obstruction, nor can reason surmise a cause for a single instance in the midst of the variety; but where, on the contrary, the variety alone of predisposing causes demolishes the whole fabric of the mechanical pathologists.

If we turn to active phlebitis, or admitted inflammation of the veins, we find it equally depending upon the predisposing causes of venous congestion, and both diseases often associated in the same organ, or presenting themselves together as complications of idiopathic fever, and often making demonstrations of the same phenomena. Shall we, therefore, in one case, impute the phenomena to a simple mechanical fullness of a limited portion of the veins, while in the other, we refer the analogous symptoms, and the venous enlargement, to a local disease whose pathology is settled upon the broad basis of organic action?

The treatment is yet in reserve as contributing largely to the comprehensive philosophy of bloodletting, and as demanding, more than any other disease, that summary remedy. Let us, therefore, study the pathology of venous congestion, as of inflammation, through the philosophy of the operation of loss of blood, and the analogies which are supplied by its effects upon all other inflammatory conditions;

nor, when deliberating upon these profound and important topics, let us neglect the coincidences in the adverse effects of tonics and stimulants (§ 662).

818. I now dismiss the great subject of venous congestion; than which none greater can undergo the attention of the philanthropist or the medical philosopher. But he may not bring to its investigation any fancied analogies, nor any of the laws, or other conditions of the inorganic world. He must start with all the philosophy of organic life, carry it all into the depths of the subject, and finally try the grand result by the test of therapeutical principles. He will then have found that he has accomplished a study of the most elaborate character, and where medical philosophy is presented in its most difficult but elevated aspects. He will have cleared up the way to all other obscurities in medicine, and have obtained a key by which he will acquire a ready access to most of the arcana of organic beings.

THE HUMORAL PATHOLOGY.

819, *a.* "To what errors have not mankind been led in the employment and denomination of medicines? They created *deobstruents* when the theory of obstruction was in fashion; and *incisives* when that of the thickening of the humors prevailed (§ 748, 789). The expressions of *diluents* and *attenuants* were common before this period. When it was necessary to blunt the acrid particles, they created *inviscants, incrassants,* &c. Those who saw in diseases only a relaxation and tension of the fibres, the *laxum* and *strictum* as they called it, employed *astringents* and *relaxants* (§ 569, *b*). *Refrigerants* and *heating* remedies were brought into use by those who had a special regard in diseases to an excess or deficiency of caloric (§ 433, &c.). The same identical remedies have been employed under different names, according to the manner in which they were supposed to act. *Deobstruent* in one case, *relaxant* in another, *refrigerant* in another, the *same* medicines have been employed with all these opposite views; so true is it that the mind of man gropes in the dark, when it is guided only by the wildness of opinion" (§ 4).—BICHAT'S *General Anatomy applied to Physiology and Medicine,* vol. i., p. 17.

"Among physical people," says Hunter, "we find such expressions in common use as, the *humors are affected in the blood; sharp humors in the blood; the whole humors being in a bad state; the whole blood must be altered, or corrected;* and a variety of such expressions *without meaning.* They even go so far as to have *hereditary humors,* as gout, scrofula, &c.; and make us the *parents of our own humors,* saying that *we breed bad humors.* Humors are even supposed to gravitate to the legs slowly; and, in short, the whole theory of disease has been built upon the supposition of humors in the blood, or *the blood itself being changed.* I cannot conceive what is meant, unless it be that *a strong susceptibility to a specific disease exists;* as small-pox may bring on scrofula, or a strain the gout."—HUNTER'S *Lectures on the Principles of Surgery,* 11th.

Affirmative.

1. "Various animal poisons, such as those of the snake tribe, and different mineral poisons, as mercury, for instance, act upon the blood. Those derangements of functions and organs produced by the experimenter, when he introduces different deleterious substances directly into the blood, are *likewise those* that are produced by the *sting* or *bite* of certain animals; they are *also those* that take place in *small-pox, measles,* and *scarlatina,* of a malignant nature, as it is called. They are *the same derangements* that appear in persons exposed to putrid emanations, vegetable or animal, and to miasmata from the bodies of other persons that are themselves diseased and crowded in confined places, &c. Lastly, *they* show themselves, also, in individuals whose blood is only imperfectly or badly repaired by *insufficient or unwholesome diet.*"

2. "There takes place a *vitiation* of the blood by the commixture of deleterious substances; *next, in consequence* of such vitiation, an alteration of the functions of the nervous system; and, *lastly,* the blood that supports the organs, and the nervous system that animates them, having suffered a general injury, a constant, though not always appreciable, modification of these organs in *their functions,* or in their texture."

3. "Diseases, resembling many of the preceding (no. 1) in their symptoms, or in the appearances discovered after death, are not unfrequently occurring where no *deleterious substance has been introduced* into the blood, and in which there is no direct proof that any alteration of that fluid has been the *primary cause* of the morbid phenomena. Here, as in the preceding case (no. 1), it appears that the *primary cause* of the disease *should be referred to the blood,* which, in this

Negative.

4. "The VITAL FORCES appear to be affected *primarily* by a great many poisons, by the vegetable or animal emanations, known by the name of miasmata, and by various modifications of the external agents which are incessantly acting upon us, such as a want of due exposure to the sun, too damp an atmosphere, and *an unwholesome diet.*"

5. "In *every* disease not immediately produced by external violence, the symptoms that occur depend either on *a lesion of the forces that animate* every living part, or on a lesion of organization (§ 177, 189 *b*). *The former is primary and constant;* the latter is secondary, variable in its nature, and inconstant in its existence."

6. "No one solid can undergo the slightest modification without producing some derangement in the nature or quantity of the materials destined to form the blood, or to be secreted from it."

7. "Until it is PROVED that the forces which, in a living body, INTERRUPT the play of the natural CHEMICAL AFFINITIES, *maintain a proper temperature,* and PRESIDE OVER the various actions of organic and animal life, are analogous to those admitted by natural philosophy, we shall act CONSISTENTLY with the principles of that science, by giving *distinct names* to those TWO KINDS OF FORCES, and employing ourselves in calculating the DIFFERENT LAWS they obey."

"The qualities of pus are modified by every alteration, whether physiological or pathological, which takes place in any other organ, even though it have no particular connection either of function or tissue. Thus, we have all seen instances of the pus secreted by the surface of a sore becoming suddenly altered in quantity and quality

Affirmative.

case, has altered its nature under the influence of *unknown causes*, as it has in the others, in consequence of the commixture of various substances."—ANDRAL'S *Pathological Anatomy.*

Negative.

under the influence of a simple moral emotion, of the process of digestion, or, in short, of any supervening disease. Nay, farther, there are certain constitutions, certain idiosyncrasies, which modify the qualities of pus, and in which it constantly assumes a peculiar and determinate character."—ANDRAL'S *Pathological Anatomy.*

819, *b.* I HAVE thus brought into contrast the prominent doctrines of the distinguished individual who enjoys the honor of having restored the humoral pathology, with the same intentions that led me to a similar display of the chemical philosophy in its applications to physiology, pathology, and therapeutics, according to the exact quantitive method of the laboratory (§ 350, $350\frac{1}{4}$, $350\frac{1}{2}$, $350\frac{2}{3}$, $350\frac{3}{4}$ *a–gg*, 438–442, 447 *f*–448 *f*). I have done this, I say, because of the general alliance of the whole philosophy, and its almost universal sway in Great Britain and France, urged on by the powerful influence of the Parisian School, of the British Association for the Advancement of Knowledge, of the British and Foreign Medical Review, the Medico-Chirurgical Review, the London Lancet, and other periodicals of less importance (§ $5\frac{1}{2}$ *a*, 349 *d*, $350\frac{3}{4}$ *k*, *kk*, 709, *note*). In considering the causes which have led to the subversion of medical philosophy, we should steadily distinguish the projectors from those who give the impulse and who govern public sentiment. It will be readily seen by every discerning mind, from my analysis of doctrines, and from what I have shown of the absence of all method, of all consistency, and the manifest want of any definite conceptions, in the chemical and physical doctrines, from the intermixture of vitalism, solidism, chemistry, humoralism, mechanical philosophy, &c., as the basis, individually and collectively, of exactly the same laws, that if the systems which are thus projected had been permitted to address themselves to the reason of mankind, truth would have enjoyed, at least, an equal chance with error. But, the opposing school decided that it should be otherwise; and nothing remains, therefore, to the few who have been thus overlooked in the haste, but to disarm, if possible, the adversary, and turn his own weapons against him. These weapons, in the phraseology of science, are facts, and upon his own "facts" the great questions at issue might be safely rested. The whole matter, indeed, must ultimately turn upon this species of evidence. The theories naturally follow. As the mind becomes enlightened about the nature of the premises, there will be no difficulty in distinguishing between the fair and the false in theory. In all medical philosophy, where so much is controverted, truth cannot be attained without a simultaneous survey of the ground-work of error as well as of truth; or if the latter take its chance upon its Heaven-born rights, it is sufficiently known that it cannot remain long in the ascendant (§ 1 *b*, $5\frac{1}{4}$ *c*).

820, *a.* I thought it an object of importance to examine the whole ground of the humoral pathology in the former work, which I had devoted to the high branches of medicine, according to the best of my humble efforts. I shall now rather invite an attention to what I have there presented, than enter again upon any circumstantial view of the subject. But, independently of the important objects set forth in the preceding section, the present work would be defec-

tive in its plan, should all regard be neglected for a doctrine so widely embraced by the educated physician in common with the ignorant pretender, and so broadly opposed to the solidism which lies at the foundation of these Institutes (§ 1 *b*, 350¼).

Moreover, there was not extant, till the appearance of the *Commentaries*, any representation of the doctrines of Humoralism, excepting such as might be gathered from the writings of its masters, or from disquisitions of a desultory nature by its opponents.

820, *b*. The restoration of humoralism is an impressive exemplification of the popularity of simple views when brought into contrast with systems of philosophy that concern profound institutions of Nature, since it unavoidably associates itself with that identical ratiocination which is the parent of empyricism, but which the more enlightened party can only recognize as the offspring of ignorance.

The essential facts, however, which are relative to the great foundations of Nature, especially in her organic department, have been too familiarly known, and their laws too well comprehended, to admit of any important innovations in medicine that shall long retard its progress, or rescue the projector from a certain oblivion. The beaten path is the only road to usefulness and enduring fame; but to achieve the latter requires the patient toil of the botanist who looks for eclat in the discovery of an unknown plant within the environs of London. Enlightened genius attempts no other route. It is alone the ambition of narrow mind, or the conceit of genius in its limited observation, that aspires at revolutions in philosophy. Hence the desertion, by the former, of that path for the old by-ways which lie obscured in the mists of antiquity; while the latter strikes out systems of such eccentricity as command, for awhile, universal admiration (§ 350, 350¼, 350½).

820, *c*. Without, however, attempting now, as on a former occasion, to assign more extensively the ground of the foregoing conclusions, I shall briefly add that I know of no recent attempted innovation upon the philosophy of organic nature, whether under its healthy or morbid aspects, and as that philosophy recognizes the principles of vitalism and solidism, but has prevailed more or less at former eras, and has been so abandoned and eradicated that it now comes up again with the interest and power of novelty. And they come to us again without having changed in one essential aspect their old thread-bare livery. That this should be so is owing to the absence of all efforts to refute the errors, excepting as transiently made in the form of opinions, and imbodied in the perishable journals of the day.

821, *a*. The humoral pathology having higher pretensions, from its dignified relations to the past, than its kindred hypotheses, should always secure for itself a patient hearing, and a full refutation (§ 1 *b*, 350¼).

821, *b*. In the brief review which I now propose, the question should be first settled as to the main doctrine of the present humoralists. This was so accurately done in my Essay on the Humoral Pathology, that the Medico-Chirurgical Review, which was addicted to that Pathology, quoted my exposition of the main principle, and allowed that it was "fairly stated." The following is the passage:

"The question at issue is not, whether the blood becomes diseased by a morbid action of the solids; and the solidist is surprised that the

defense of humoralism should often turn upon labored attempts to prove what every body admits. Nor is it, whether vitiated blood, or putrid matter, will excite disease when injected into the veins. The question at issue is, *whether foreign morbific causes, and remedial agents, in their ordinary modes of operation, produce their primary effect upon the solids or upon the blood, and the latter become the cause of disease in the former; whether we 'have hereditary humors, as gout, scrofula,' &c., and whether we are 'the parents of our own humors, and that we breed bad humors,'*" &c.—*Med. and Physiolog. Comm.*, vol. i., p. 636.

In the same Essay I have quoted many recent authors, as setting forth the doctrine in exact conformity with its ancient impurities, and as promulgated in the newspapers of the day. A paragraph embraces all that is essential in the science of medicine; or, should the facts, the basis of the science, form an accompanying part, the whole is comprised within a moderate pamphlet entitled "*Organic Chemistry in its Application to Physiology, Pathology, and Therapeutics*" (§ 5½, 350, 350⅔).

821, *c*. It may be interesting to some should I annex the precise *modus operandi* of morbific agents, as expressed in almost every work, ancient and recent, which recognizes the humoral pathology. The learned and distinguished Dr. Hosack shall speak for the school and its imitators. Thus:

"That 'a little leaven leaveneth the whole lump' *is as true in fevers as in making bread*, or in the conversion of acescent fluids into acetic acid; and *that* upon the *same principle of assimilation.* That one spoiled herring will taint the whole cask, is well known to every housewife or fish-monger. Hence the great care of the Dutch in their herring fisheries to salt down their fish as soon as they are taken. They never permit the sun to rise upon them" (§ 830, *b*). And so, also, the chemists (§ 350, nos. 44, 45).

Although, as will be seen by the references, the exact chemical school differ from the foregoing in respect to the *modus operandi* of the *mind* and *passions*, they agree as to the physical agents; even to the Dutch herring (§ 349 *e*, 350, no. 44, &c.). So far as these illustrations go, it must be in justice admitted that they are peculiar to the walks of science, and are the rightful trophies of "experimental philosophy." "*Qui meruit palmam,*" &c.

In connection with what I have now said should be taken the details of the philosophy as expounded by its late restorer, which may be seen in the introductory matter, and in subsequent sections.

Such, then, by universal admission, is the philosophy of humoralism; and that it has no better foundation I have endeavored to demonstrate in my former Essay (§ 4, *b*).

822. On the other hand, what says the solidist? He tells us that, however simple the foundation (§ 638), disease and its cure depend upon the most intricate system of laws; far beyond any thing in the inorganic world: That these laws are associated with properties which are peculiar to organic beings, and determine all their natural processes: That all morbid conditions consist essentially in alterations of the properties and functions of the solid parts: That alterations of the blood are only consequences of these essential changes: That all practical medicine consists in restoring these solids to their nat-

ural state, without reference to the existing condition of the blood, excepting in the aspect of symptoms: That it is only through the agency of the renovated solids, whose morbid state had affected the condition of the blood, that this fluid can be in any respect diverted from its modified conditions, or restored to its integrity.

Finally, we are told by the solidist that medicine, in any one of its branches, cannot be taught in the compass of a pamphlet.

823. There are some eight or nine principal positions taken by the present humoralists in the way of tangible proof. With the exception of the second following, they are the same as are disseminated in the books of the older writers. They are now, for the first time, condensed into a methodical order from extended disquisitions in the Commentaries; namely:

1. That substances deleterious to life have been known to be taken into the circulation through the lacteals (§ 826).

2. That gaseous and fluid substances, having an affinity for each other, permeate and unite through a dead animal membrane (§ 827).

3. That morbific agents, when inserted in wounds, give rise to diseases in various parts (§ 828).

4. That injections of various substances, and morbid blood, into the circulation, produce disease in the solids, and occasion death (§ 830).

5. That when many substances, as salt and acids, are mixed with the blood out of the body, they affect its sensible character apparently like the changes which happen to the blood when circulating in the living organism (§ 832).

6. That when certain substances, such as yeast, are added to dead organic compounds, like vegetable infusions and dough, they create an intestine commotion. The example of a putrid fish, which is of the same nature as the preceding, contaminating a barrel of sound ones, has been lately, as formerly, adduced in high quarters to prove the soundness of humoralism (§ 833).

7. That the blood, in certain conditions of disease, undergoes changes in its appearance; especially in refusing to coagulate, and in being of a dark color; and that chemists, also, have sometimes detected a variable composition (§ 834).

8. That morbid changes occur in the secreted and excreted products (§ 835).

9. That diseases are transmitted from parent to child (§ 836).

10. That remedial agents, when injected into the circulation, sometimes produce the same effects upon particular organs as when administered by the stomach (§ 837).

11. That certain vegetable tonics, containing an astringent principle, will increase the physical strength of dead muscles, vessels, membranes, &c. (§ 842).

824, *a*. So far as my knowledge extends, the foregoing admitted facts constitute the entire foundation of humoralism; and it will be seen that not a single one of them has any sound relation to physiology! But what do they prove? Nothing whatever beyond the simple fact affirmed by each proposition (§ $5\frac{1}{4}$). No one of them has the least bearing upon the questions relative to the natural operation of morbific causes, nor of remedial agents when employed according to the only methods that are sanctioned by nature or by art. We have also before us a remarkable display of the general habits of mankind

in respect to the value of evidence in that sense which Nature has ordained as the basis of her institutions. Here we see nothing but a factitious assemblage of analogies for the foundation of great principles in medicine, devised by those very philosophers who condemn all conclusions in this science that are predicated, in other systems of philosophy, of those analogies which are impressed upon the face of Nature. Nor is it less worthy of remark, that the school in chemistry, who aspire at more exact applications of analogy to the healthy and morbid processes of the living being, borrow the whole from the inorganic world, and, for its better success, condemn this method of induction as employed by the vitalists in their study of organic phenomena.

824, *b*. Most of the foregoing premises in humoralism are brought into view in various parts of this work in their appropriate relations to special principles in physiology, pathology, and therapeutics; and the subjects are too extensive for elaborate consideration. In the Essay embraced in the Commentaries they have been subjected to all the examination which farther experience and reflection would enable me to bestow.

825. Humoralism, however, has now become so generally prevalent, and is sustained by so powerful an array of "authorities," and as my own writings afford the only systematic view of the subject, I shall, for the advantage of the young inquirer, present such a condensed and connected statement of my grounds of objection as will enable him to comprehend the misapplication of facts, and to apply them in the manner which appears to have been ordained by nature (§ $5\frac{1}{4}$). I shall, however, introduce other facts and arguments, that they may be taken in connection with the former, and shall simplify the subject by adopting a method in conformity with the foregoing propositions (§ 823). But it will be my object to bring into view the great principles which bear upon the several specific statements, either directly, or by reference to other sections. These references, therefore, will form an important part of the investigation, as they connect it with various principles and facts in physiology (§ 639, *a*).

826, *a*. As to the first proposition, that substances deleterious to life have been taken into the circulation through the lacteals, I object, that the phenomenon is rare, that it has been mainly ascertained of certain mineral substances, and that these, as allowed by the chemists, are eliminated by the kidneys in from five to fifteen minutes after their absorption (§ 280). The lacteals, on the contrary, elect, with astonishing precision, the nutritive chyle, and reject the rest. This is due to the exquisitely-modified irritability of these vessels; just as has been seen of a like provision in the glottis, the pyloric orifice, and vessels which exclude the red globules of blood (§ 191, 192). Nor can we too much admire the Wisdom which embraced in one universal Design the general good of the organism by so endowing the lacteals that they shall exclude all things which are not in harmonious relation to the special vital states of every other part (§ 274–295).

When such substances effect their entrance through absorbing vessels, it is, as we have seen, by modifying their irritability, and thus establishing relations with them; just as undigested food escapes a morbid pylorus, or the red globules of blood enter the serous vessels in inflammations. Bile, &c., are incapable of producing such modifi-

cations of the lacteals, and are, therefore, forever excluded. Here, too, morbific or remedial agents act in their concentrated state, and supply a ground for interpretation, through the laws of sympathy, of the remote phenomena; while the little that may gain the general circulation is so diluted, and so soon excreted, as to be worthless in our estimate of causes.

286, *b*. It should be also considered, that, notwithstanding the rapidity with which foreign matter at all offensive to the organism is eliminated by the excretory organs (§ 280), the blood and entire body may have undergone many renewals between the application of the predisposing cause and the explosion of disease; that hydrophobia may not supervene for months or for years, fever for a year or more, and may then return at annual periods; that salivation may follow a very minute quantity of mercury, and may be continued long after the saliva and other secretions have flowed in great redundancy, &c.; while, on the other hand, the interpretation of their modus operandi, according to the philosophy which I have propounded, is in perfect harmony with every principle advanced in these Institutes, and invites the severest scrutiny. In connection, also, with these topics should be considered all that I have expounded of the laws of sympathy, vital habit, constitution, acclimation, temperament, &c. As to the oft-alleged smell of garlic in the excretions, of the coloring matter of madder in the bones, or of the bile in all parts of the body, they are among the most attenuated of material substances, and are inoffensive to the lacteals and the general organism. (See, also, *Med. and Physiolog. Comm.*, vol. i., p. 523–557, 576–581, 589–594, 599–608, &c.)

826, *c*. Nor should it be neglected, that there is no agreement among chemists as to some of the most important morbific and remedial agents which have been said to gain a ready admittance to the circulation, and that the most positive affirmations predicated of elaborate experiments, like those of Orfila in respect to arsenic and antimony, have been shown to be false by their cotemporaries, and through improved means of observation. The foregoing substances, for example, were given to dogs in large doses, by Flandin and Danger; but "at whatever time, subsequent to the administration of the poisonous doses of arsenic or antimony, blood was drawn from the arm for examination, they never found either substance in the blood." It is also worth adding, that Orfila remarks that, "I shall only say, in reply to Flandin's charge that I consider the animal body in the light of a mere *sponge*, that I follow Magendie and Fœdrè entirely in their theory of absorption" (§ 289–293, 350½ *n*, *o*, 744, 841. Also, *Med. and Physiolog. Comm.*, vol. i., p. 529, *note*, &c.).

826, *d*. I may also contrast the facts, that many of the most virulent poisons, such as the virus of the viper, of the rattle-snake, of the mad dog, of the wourari, &c., are perfectly innoxious when swallowed, or when applied to any sound part of the body, even to the brain (§ 828), while a vast variety of other agents, far less offensive, will immediately affect those parts, and through them the system at large (§ 150, 494 *d*). Mercury, in its metallic or oxydized state, and, of course, insusceptible of absorption, will affect the universal system through the medium of the skin; and if the latter organ sustain any corresponding or other effects, they arise not from the direct action of the agent, but from reacting sympathies. These problems have been ex-

plained in preceding sections, where some important experiments occur (§ 133, &c., 150–152, 177–184, 222–233½, 283, 452, &c., 476–493, 494, 500, 514 *d*, *h*, &c., 650, 657, 666).

The student should not be led into the error of confounding the results of agents applied to the trunks of a nerve and to its extremities. The physical philosophers have taken advantage of the comparative failure of the former to show that morbific and remedial agents do not produce their remote effects through the medium of the nervous system, and have adopted this view from Müller's misapprehension of the subject. "The narcotic action of opium," says Müller, "does not react from a particular point of a nerve on the brain." Therefore, argue the materialists, when applied to the surface of tissues, its narcotic effect is due to absorption. But the great Physiologist has shown, himself, the error, while, at the same time, he proves the untenable nature of humoralism. Thus:

"The spirituous extract of nux vomica, introduced in a small quantity into the *mouth* of a young rabbit, produces immediate death (in a second of time); whereas, when applied to a nerve at some distance from the brain, for instance, to the ischiadic nerve, it produces no general symptoms" (§ 494 *dd*, 498 *c*, 514 *d*).

There is the broadest distinction between the trunk of a nerve and its expanded extremities in connection with organic tissues; while, also, the organic properties of the terminal fibres, and especially sympathetic sensibility (§ 201, 451 *d*), are incomparably more strongly pronounced than in the nervous trunks. The important consideration has been also neglected that two orders of nerves are concerned in the function of remote sympathy as it occurs naturally, and that the points of departure and of incidence are the expanded portions of the nervous system. This is also undoubtedly true even of the sympathies of the nervous system itself, which embraces all the elementary parts of other organs (§ 472, no. 4, 514 *d*, 516 *d*, 526 *d*. Also, *Med. and Phys. Comm.*, vol. i., p. 507, 563–566).

Moreover, when irritating, or other agents, produce strong impressions upon the surfaces of organs, it is not, as supposed by Müller and others, mainly upon the ramifications of the nerves, but may be equally, at least, upon the organic properties of the other tissues of the part (§ 184, 188). Hence, particularly, the wide difference in the effects of irritants, &c., when applied to the trunk of a nerve and to an organ of a different vital constitution; as shown, for example, in the action of vesicants (§ 133, &c.). The insusceptibility of nervous trunks is also farther shown by their remarkable exemption from the action of morbific causes (§ 526, *d*).

827, *a*. The second fundamental proposition of humoralism is the fact that gaseous and fluid substances, having an affinity for each other, permeate and unite through a dead animal membrane.

That fact is undeniable. But what is its physiological aspect? Is it worthy, in any other than its naked relations to chemistry, of grave consideration? And so of the entire amplitude of *endosmosis* and *exdosmosis*. There must first be shown a correspondence between a dead, permeable tissue, and a living, impermeable one, before we can proceed to apply the foregoing fact in any physiological bearing. But its utmost latitude would only show that foreign substances unite *chemically* with the blood through the living tissues; but that this is

disproved by all organic nature, I think the reader will concede after consulting the following references (§ 135, &c., 350½ *n, o, p*, 350⅔ *f*, 376½, 398, 408, 409, 419, 420, &c., 423, 500, 805. Also, *Med. and Phys. Comm.*, vol. i., p. 565, 683, &c.).

827, *b*. Of all the agents which surround us, oxygen gas is the only one which has been shown, with any degree of plausibility, to penetrate a living animal tissue, or to unite chemically with the blood, or with any supposed constituent of that fluid. If it be allowed, also, that this has been demonstrated, nothing can be predicated of it analogically in respect to other extraneous matters, since it is an ordained function of organic life, under the control of specific laws in the animal and vegetable kingdoms, and conducted through special parts of the organism. The philosophy is the same as we recognize in all other parts. It is the office, for example, of the chylopoietic and sanguiferous organs to rearrange the elements of food, and endow the new compounds with the properties of life; while it is that of the glandular organs, the membranes, &c., to select certain constituents from the common homogeneous mass by virtue of these vital properties, and to impress upon them various peculiarities, according to the mechanism of each tissue, and as the vital constitution of each part may happen to be modified (§ 18, 42–44, 133, &c.).

Coming again to the specific uses of oxygen in the organic kingdom, the relative laws, the organs, the final causes, &c., are also different in the two organic departments, and even varied as to organization in animals; yet in all according to other variations in the general physiological constitution (§ 133–151, 185, 259–295, 409, 410).

But, I think it must be conceded that I have shown that there is no physical penetration of the pulmonary mucous tissue even by oxygen gas, and that the formation of carbonic acid within the lungs is primarily due to a strictly physiological process (§ 135, 419, 433, &c., 447½ *a–f*).

I am now conducted to a fact which illustrates the principle on which miasmatic poisons operate.

It is well known that adult dogs, &c., will bear, with impunity, a suspension of respiration for the space, at least, of five minutes. But they perish immediately if plunged into carbonic acid gas. Therefore, say the humoralists, the gas is absorbed in the latter case, which makes the difference in results. This, however, is contradicted, in the first place, by the ordination of nature that carbon shall be evolved from the lungs, and by an organization of the mucous tissue of the lungs corresponding to that fundamental law; whether the process be the result of chemical or vital actions, or both united (§ 447½, *f*). Organization is thus specifically opposed to the absorption of carbonic acid. As well might it be assumed that gastric juice is resorbed by the mucous tissue of the stomach. Carbonic acid, therefore, does not destroy by absorption and union with the blood (§ 419, 420).

But this incontrovertible philosophy is sustained by direct experiment; since it was found by Nysten that "carbonic acid gas may be injected into the venous system in large quantities, without stopping the circulation, and without acting primitively on the brain; but when more is injected than the blood will absorb, it produces death by distending the heart, as when air is injected into the veins."—NYSTEN, *Récherches*, &c., p. 88.

Here, then, we have the principle demonstrated, which is of universal application to mephitic gases, upon whatever surface their action may be exerted. The poisonous action of carbonic acid is exerted upon the pulmonary mucous tissue, and only then upon the brain, as a consequence of that primary effect, and through the physiological relations of the mucous tissue of the lungs to the great nervous centre (§ 129, 137, 222, &c., 666. Also, *Med. and Physiolog. Comm.*, vol. i., p. 443, &c. This lets us into the secret why many poisons, as that of the viper, of the mad dog, of the wourari, &c., have no action upon the stomach, or when applied to the surface of the brain, but operate with violence when inserted within the organization of the skin, and why that of the rhus vernix, &c., will affect the skin when applied only superficially (§ 135–137, 140, 150).

Again, in connection with the foregoing illustration, it is an important fact that animals may be destroyed by the application, for a considerable time, of carbonic acid to the skin, although free respiration of atmospheric air be permitted. This shows that it may also exert a deleterious action upon the organic constitution of the skin; and by analogy, therefore, such may be more or less the case with malaria. And it should be farther stated, that the action of carbonic acid agrees, also, with that of concentrated forms of malaria in the instantaneousness of its effects (§ 654, *a*).

827, *c*. An almost endless series of examples of clear, definite character illustrate the philosophy of more obscure but analogous problems. Another, for instance, may be found in the effects of the nitrous oxide gas, when respired. Here, the immediate production of the phenomena, and more especially the abruptness with which they subside, prove that the whole action of the gas is upon the pulmonary mucous tissue, and that the general phenomena can be in no respect owing to a modified state of the blood, or to the absorption of the agent. We have already variously seen how the morbific impression may be produced without exciting any manifest disease in the part upon which the primary impression is produced. The example of cold in producing pneumonia, or rheumatism, &c. (§ 649 *c*, *d*, 657, 666), the fatal action of hydrocyanic acid, aconitina, strychnia, &c., the remedial influences of tartarized antimony, of the mercurials, and of numerous other alterative agents, concur in one general illustration of this subject (§ 494 *dd*, 550–563). The philosophy relative to the nervous power conducts us through all the labyrinth of the wide-spread influences that radiate from a given point which may seem almost alone exempt from the general invasion of disease (§ 222, &c., 500, 512, &c.).

727, *d*. The present place supplies a good opportunity for introducing a case of death from hydrocyanic acid; partly with a view to our present subject, and to serve, in part, as a reference to illustrate other topics. Thus:

A medical gentleman had swallowed a fatal dose of Scheele's hydrocyanic acid, from which he died in about ten minutes. "On cutting into the right lung, a frothy, dirty-brown semi-mucous fluid exuded, tinged with blood. There was no odor of prussic acid from it. In the cavity of the right pleura were about eight ounces of thin serum. The left lung was firmly adherent in its whole extent to the costal pleura. Heart firmly contracted. It exhaled no smell of prussic acid. Liver healthy. Spleen soft and easily broken down, resembling mul-

berry jam. Kidneys natural. The stomach contained about fifteen ounces of half-digested food, that gave out the well-known odor of bitter almonds. The mucous coat of the stomach healthy, and *smelled strongly of prussic acid* after the stomach had been emptied of its contents (§ 657). Intestines healthy. *Vessels and sinuses of the brain filled with a dark-colored fluid blood.* No smell of prussic acid. Blood every where fluid" (§ 494, 904 *b*).—MR. POOLEY, in *London Medical Gazette*, 1845.

827, *e*. The foregoing philosophy enables us to understand why the morbific action of miasmata is promoted by various causes which increase the susceptibility of the system (§ 663), and which has its parallel in numerous examples of daily occurrence; as the greater liability of mercurial agents to produce salivation if we increase irritability by cathartics, bloodletting, &c. (§ 556 *c*, 837 *b*); while, on the contrary, had humoralism any foundation, cathartics and bloodletting should diminish the chances of mercurial action, nor should that action increase long after profuse ptyalism has been established. (See *Modus Operandi of Remedial Agents*, § 892, &c., and *Vital Habit, Constitution*, &c., § 535–638.)

It should be observed, also, that upon the hypothesis of humoralism there should be no exemption of individuals from epidemic diseases, since the blood of all should be equally liable to contamination. Humoralism may not, consistently, assign as the ground of exemption a difference in the susceptibilities of the solids which have been induced by other causes (§ 651 *b*, 657 *a*, 837 *b*); and since, therefore, the blood is the *pabulum vitæ*, and convertible into the solids, it should, upon the humoral doctrine, when itself diseased, occasion universal disease of the solids (§ 663). The same is also true of the poisons, of the prick of a pin, &c.; but always affecting some severely, and others slightly,—the former sometimes striking at one organ, and again at another, while the latter induces in one man erysipelatous inflammation, in another always phlegmonous, and in a third none at all (§ 652 *c*, 828 *c*).

827, *f*. If, however, it be admitted that offensive substances, when absorbed, operate through the medium of the circulation, solidism and vitalism can alone interpret the phenomena. There is abundant proof that the results are not due to any affection of the blood, but must be referred to the direct action of the agents themselves upon the vital constitution of the solids to which they are distributed. This construction of the subject, therefore, is directly within the pale of solidism; though it be foreign from the truth.

827, *g*. Again, however, most of the substances whose presence in the blood or secretions can be detected (*a*) are either innoxious, or undergo chemical decomposition as soon as they come in contact with the circulating mass, and would therefore either be rendered inert, or would certainly give rise to different phenomena from those of the agents in their original shape (§ 52, 149, 650).

827, *h*. But this part of the doctrine of absorption does not end with gaseous substances; since there are some distinguished philosophers who maintain that *seeing* is produced by the penetration of light to the recesses of the brain, where it gives rise to certain cerebral changes that result in vision; just as Liebig and his school suppose that all the operations of the mind are determined by chemical chan-

ges of the brain (§ 349 *e*, 350½ *n–q*). By the analogies of Nature, therefore, we must conclude that, whatever gives rise to other sensations, must be equally absorbed and conveyed to the sensorium commune,—the odor of plants, the undulations of air, the prick of a pin, &c. (§ 837, *b*).

828, *a*. The third proposition of humoralism sets forth, that when morbific agents are inserted in wounds, they give rise to diseases in various parts.

Here, then, we have something besides denuded surfaces. The "facts" which I have considered in the preceding propositions were evidently unsatisfactory to "experimental philosophy," and, therefore, a start has been given to absorption by inserting the noxious agents within the vascular systems. But, I have gone extensively, in the *Commentaries*, into the proof that in all the cases of this nature, the agents have been either violently forced into the torrent of blood, or that their direct effect is exclusively upon the injured part, and thence propagated sympathetically over the system. It will be also observed that in these experiments the agents are brought into direct contact with parts where the organic properties are most exquisitely developed and susceptible. The time of incubation (§ 666) may be from an instant, as with hydrocyanic acid and strychnia (§ 350½ *p*, 594, 743, 826 *b–d*, 827 *d*, 904 *b*), to a year or more, as with the cause of intermittent fever (§ 561, 657), or even to years, as with the hydrophobic virus (§ 547, 559, 560, 654–659, 500 *o*, 503, 506, &c. Also, *Comm.*, vol. i., p. 496–506). As to the last, the virus can neither remain in the wound, nor circulate in the changeable body, for years, or for months. It is either washed away from the former, or carried off by the latter.

Now all these cases are exactly upon a par, so far as principle is concerned. The same influences obtain in respect to the hydrophobic virus, as with those agents which destroy life as soon as they come in contact with the body. This is the work of the nervous power; just as it is when joy, or anger, or a surgical operation, or blows on the stomach, &c., kill in an instant of time (§ 227, 230, 234 *e*, 476 *h*, 509–511). The principle is the same as when the division of a nerve excites inflammation in the part to which it is distributed. Now all this conducts us, at once, to a knowledge of the *modus operandi* of the poison of venomous animals in the following comprehensive case.

828, *b*. "I have seen," says Dr. Johnson, the late distinguished editor of the Medico-Chirurgical Review, "the ear of a rabbit exposed to the bite of a cobro de capella, with a pair of scissors kept across the ear, ready to cut it off the moment the bite was inflicted; yet the animal died quickly in convulsions" (§ 234 *e*, 507, 826 *d*).

The foregoing fact corresponds exactly with experiments of a very different nature by Van Deen, Stilling, Budge, &c. (§ 494), and forms, with those, substantial grounds for analogical inductions. They may be safely considered of universal application, whatever the morbific cause, whatever the interval of predisposition.

828, *c*. It is astonishing, too, with what rapidity certain morbific causes will establish inflammation, and thus lead to an almost instantaneous disorganization. Take another example from the venomous serpent, as related by Sir E. Home. He caused a rat to be bitten by a snake. It died *in one minute*. The cellular membrane beneath

the wound was wholly destroyed, the muscles separated from the ribs and from a small extent of the scapula. The bitten part was greatly inflamed.

Here the inflammation must have commenced in the region of the thorax at the moment the bite was inflicted. Absorption and distribution were, of course, impossible, and there is nothing but the philosophy which I have propounded of the nervous power that will in the least explain the phenomena in this and all analogous cases (§ 222, &c., 234 *e*, 503, 509). By the foregoing case we are also prepared to understand that hydrocyanic acid may light up venous congestion in the brain, although it destroy with equal rapidity (§ 827, *d*).

828, *d*. Finally, an elementary example of universal application to morbific agents, and illustrative of the nature of life, will supersede the necessity of farther comment upon the three fundamental propositions of humoralism as it respects absorption (§ 823). This example is of the same nature as that of the ***seton***, farther on; but more open to the understanding of all (§ 905).

It will be admitted that when inflammation is excited by the puncture of a lancet, it is not by irritating, or otherwise affecting the blood; but that all the attendant phenomena are due to an impression made upon the solids, and to their consequent morbid action. The inflammation, thus excited, may be extensively and violently propagated along the part, as in phlebitis, &c. (I specify a vein, as it is here the acrid injections are made, § 830); and it is but reasonable to suppose that the same condition is owing to a similar cause at one or six inches from the wound, as at the eighth of an inch. No sooner, also, does the inflammation begin than remote sympathies may come into play; but as we have no morbific blood in these cases, we must look for some principle, analogous to that in which the local changes began, to explain the general derangement (§ 500, 711, &c.). All this will help us to the philosophy of analogous developments in diseases of reputedly humoral origin. But, besides the common effects of inflammation, the prick of the lancet may convulse the whole nervous and muscular systems (§ 222, &c.). Nay, more, and greatly to our purpose, the inflammation arising from a wound will be variously modified in its character by the exact nature of the wound itself, and the kind of instrument or violence with which it is inflicted (§ 652, *c*).

If there be now added to the point of the lancet sulphuric acid, or the virus of putrid animal matter, of the small, or cow-pox, or the poison of the viper, of the wourari, &c., there will be many diversities in the general results of the several causes thus superadded to the mechanical, but strong resemblances in the local phenomena, and in the progress of symptoms. The specific products, also, as well as other circumstances, denote specific modifications of a common pathological state (§ 722, &c.). If, then, the mechanical irritation in one instance have acted directly upon the solids, is it not a proper conclusion from the progress and analogy of symptoms, that the several varieties of poison have done so in the others? It cannot be said that certain differences in the results imply a difference in the principle, since all these results, where life is sufficiently prolonged, are purely secondary, and will be admitted to be consequent on the morbid affection of the solids. But all the primary phenomena in such instances coincide with each other, and have the same order of development

If the poison of the viper destroy life with great instantaneousness, this is conclusive against absorption, and is exactly allied in principle to the fatal operation of a blow upon the region of the stomach, or of surgical operations which produce instant death, or of the prick of a pin which is followed by tetanus (§ 494 *b*, 509, &c.).

828, *e*. There is an endless variety of analogies where disease is excited by agents of a mechanical, or even of a more negative nature: such as cold, heat, wakefulness, fatigue, &c., which, like the operations of the mind or its passions, in producing or removing disease, killing or curing, according to the exact nature of the intellectual process, that are applicable with all the force of the strongest analogies to show that in all other cases the same laws prevail (§ 188½ *d*, 527 *b*, 902 *m*, 905).

829. "When we consider," says Pereira, "the peculiarities attending the hepatic circulation, and that all the remedial agents, whose particles are absorbed, have to pass through the portal vein,—the vein by whose branches the bile is secreted,—*our astonishment is great* that this secretion is not more frequently affected *by the various medicinal agents put into the stomach*."—Pereira's *Mat. Med.*, p. 92.

May we not, however, rather be astonished that the frequent exemption of the liver itself from all morbid effects, as well as the condition of the bile, did not satisfy our able author that the doctrine of remedial and morbific action by absorption is contradicted by the plainest facts (§ 889, *a*)?

Our author, however, has been led into an important physiological error by Magendie's assumption that the veins, and not the lymphatics, perform the office of absorption; while in respect to any ingress of deleterious agents, it is mostly by way of the lacteals (§ 260). Admitting, therefore, that the violent agents of the Materia Medica operate by absorption, they are first conveyed directly to the heart through the thoracic duct; and if "astonishment" be great in the mistaken case of the liver, how much greater should it be when we consider the realities of nature, and observe how often the exquisitely irritable heart remains unaffected when the most powerful irritants are emptied into its right cavities. Or taking the construction of our author, the effect upon the heart would be equally the same, since a large proportion of the portal blood is delivered at the same cavities. In either case, the irritants would exist in a state of concentration in the most irritable organ of the body compared with their dilution in other parts, except the lungs, as 1 to 50, or more. And yet the heart often remains undisturbed in its regular action after the administration of violent agents, while they are simultaneously healing, or inflicting disease on other parts. I present, therefore, this isolated fact as adequate in itself to a full refutation not only of the doctrine of morbific and remedial action by absorption, but, by the force of analogy, to that of the entire system of the humoral pathology. If embarrassing to the humoralists in the case of the inirritable liver, it is conclusive in that of the heart.

830, *a*. The *fourth* grand assumption of humoralism, as a part of its basis, is the production of disease and death by the injection of various substances into the circulation (§ 823). These injections are made upon *animals*, and their effects carried up to the natural morbific causes on *man*.

Strange as is this analogical ground of induction, it is, nevertheless, the great bulwark of humoralism. The doctrine is thus set forth by its restorer, M. Andral:

"Various animal poisons, such as those of the snake tribe, and different mineral poisons, as mercury, for instance, act upon the blood in the *same manner* as deleterious substances injected into the circulation." "Those derangements of functions and organs produced by the experimenter, when he introduces different deleterious substances directly into the blood, are *likewise those* that are produced by the *sting* or *bite* of certain animals; they are also those that take place in *small-pox*, *measles*, and *scarlatina* of a malignant nature, as it is called. They are the *same* derangements that appear in persons exposed to putrid emanations, vegetable or animal, and to miasmata from the bodies of other persons that are themselves diseased and crowded in confined places, &c. (§ 653). Lastly, they *show* themselves, also, in individuals whose blood is only imperfectly or badly repaired by *insufficient* or *unwholesome diet*" (§ 744, 819 *b*).

830, *b*. The order of results as stated by Andral, and as adopted by all humoralists, is the following:

"A *vitiation* of the blood by the commixture of deleterious substances. *Next*, in *consequence* of such vitiation, an alteration of the functions of the nervous system. *Lastly*, the blood that supports the organs, and the nervous system that animates them, having suffered a general injury, there takes place a constant, though not always appreciable, modification of these organs in their *functions*, or in their texture" (§ 709, 740, 744, 821, 847 *d*).

831. Injections of noxious agents into the circulation of animals were made to an almost incredible extent centuries ago; and millions, I may safely say, have been repeated in later times. But they prove only two things,—their short-sightedness and inhumanity. They certainly do not show, in the least, that the ordinary causes of disease are taken into the circulation, nor do they produce those constitutional affections which are generated by the natural operation of morbific causes, especially on the human species. Their action is commonly upon the venous system; and if the reader will refer to my remarks upon phlebitis, he will perceive the reason for the conclusion of many experimenters that they have given rise to yellow fever, typhus, &c., in the brute race (§ 744, 810, &c.).

These devices of art are very extensively considered in my Essay on the Humoral Pathology, where I have endeavored to show that they all go to the proof of solidism (§ 827, *f*).

832. For an examination of what I have designated as the *fifth* proposition in humoralism (§ 823), I must refer the curious reader to the *Commentaries*, vol. i., p. 401–408, 431–451).

833. The *sixth* foundation is relative to the yeast and herrings; and the reader will probably be satisfied with the references to this subject which occur in § 821, *c;* otherwise, he may consult section 350, nos. 44, 45; and the *Commentaries*, vol. i., p. 417, &c.

834. The *seventh* fundamental assumption goes with the *fifth*, and the reader, by the references there, may satisfy himself of their degree of importance.

835. The *eighth* bulwark of the doctrine is the important fact,—important to the solidist,—that morbid changes occur in the secreted

and excreted products. Nor is it less important in its philosophical and practical bearings upon the humoral pathology; since it is undeniable that it places the learned and the unlearned practitioner on common ground. Their pathology is the same; and what is affirmed in the following extract of the educated, in respect to their practical habits, every newspaper in the land assures us is equally true of the pretender in medicine. Thus the extract:

"The humoral pathologist neglects the study of visceral lesions; and when he turns his attention to the digestive system, he only considers its secretions, and not its actual condition, or the state of its sympathies. His sole purpose is to evacuate sordes, or to produce a flow of healthy bile, and to eliminate depraved secretions; and this he attempts without possessing any knowledge of the effects of disease of the digestive system on other organs."

Professional humoralism assumes that these "vitiated secretions" are due to a morbid state of the blood, and not to perverted actions of the solids, which, in their ordinary state, give rise to the various natural products. And so the newspapers. Perhaps, however, the student may obtain some ideas to the contrary, by consulting the following references (§ 42, 44, 53, 135, 220, 222–233¾, 284–292, 307, 314, 322–326, 327–331, 407–432, 452, &c., 500, &c., 512, &c., 674, &c.).

836. The *ninth* ground of induction goes back to ancestral diseases; and assumes their transmission, by hereditary impurities of the blood, to succeeding generations. I have referred sufficiently to the philosophy of this subject in the present work (§ 75–80, 143–147, 220, 327–331, 559, 561–563, 591, 659, 666 *b*, 674), and more extensively, and in other aspects, in the *Commentaries* (vol. i., p. 464, &c.). I shall not, therefore, again encounter this part of the foundation; but cannot refrain from adverting to its pernicious effects in practice. One of its vague attendants is the doctrine of "poverty of the blood," and this, as practically applied to active conditions of scrofula, is a fearful scourge to the human family. The "enriching black meats," and the "sustaining cordials," which are every where commended to the subjects of phthisis, in its early stages, are the occasion of a greater mortality in one day than ever proceeded from the abstraction of blood in all diseases since medicine became an art (§ 620, *note*. Also, *Comm.*, vol. ii., p. 608–634, "*Pathology of Tubercle and Scrofula*").

837, *a*. Humoralism assumes, as its *tenth* fundamental basis which I have indicated, that remedial agents, when injected into the circulation, sometimes produce the same effects upon particular organs as when administered by the stomach (§ 823).

Rarely has this experiment been tried on man, in recent times; probably in consequence of the mere transfusion of blood having been fatal, and interdicted by law, in former times. It is almost entirely limited to animals; when, as might be expected, the agents exert their effects mostly upon the venous system; "giving rise to *scurvy*, *yellow fever*, *typhoid fever*, &c., not to mention a number of *other affections which I called into being before you*" (§ 744, 709, 810).

The case in which Dr. Hale, of Boston, injected castor oil into his own circulation is a standing reference; but like the "Secretary," it "stands alone." What though, however, it rewarded the gentleman with a few moderate evacuations, I have never yet seen it affirmed by

the pathological chemist, not even by Orfila, that castor oil has been detected within the organism after its exhibition by the stomach; and we need not doubt that the experiment has been satisfactorily tried.

837, *b*. That certain articles of the materia medica which manifest specific relations to particular parts when administered by the stomach, will exert specific effects according to those relations, when injected into the circulation, is clearly inferable from the first principles in physiology. If vomiting result from the mere action of tartarized antimony upon the mucous surface of the stomach, and purging from that of castor oil on the intestine, it should probably follow that the same results will happen when either of these, or analogous agents, are injected into the veins, and are circulating within the very organization of parts possessing superficially those relations to the same agents (§ 150). Each series of observations, however, stands independently by itself. The injections prove nothing beyond their own results. They can have no bearing upon the question of superficial action; and we may as well deny that croton oil, hellebore, elaterium, &c., act upon the skin when they produce inflammation of that organ, as to deny the same local action upon the intestines when they increase their motion, augment their secretion, or inflict inflammation upon them; we may as well deny, I say, that we feel with the ends of our fingers, or assume that offensive odors, tickling the throat, warm water, and mental emotions, produce vomiting through the medium of the circulation. Humoralism must group the whole under one category, and must include all those varying susceptibilities which arise from habits and analogous causes as exerting their morbific effects upon the blood; for the moment it regards the solids as taking an initiatory step, it opens a door for its own expulsion (§ 651 *b*, 827 *e*).

837, *c*. A great variety of examples might be adduced in proof of the repugnance of nature to the doctrine of humoral absorption as commended to our confidence by the experimentalist, and which equally confirm the vital theories of morbific and remedial action, whether the agents be applied to the mucous tissue or to the skin. What, for example, would be the condition of the acetate of lead, or the nitrate of silver, or sulphuric acid, were they absorbed from the stomach? Utterly changed, perfectly inert, on their contact with the blood. How, then, does sulphuric acid, or the acetate of lead, arrest the night-sweats of phthisical subjects? What disposition, I say, will you make of the universal effects of certain insoluble substances applied to the skin; as the insoluble preparations of mercury? How will you account for the well-known action of nitric acid upon the liver, when applied in the form of *pediluvium?* Interrogate the chemist as to the condition of all these things, and many other analogous remedial agents, when he mingles them with the blood.

The experiments, therefore, have no tendency to prove the doctrine of absorption. On the contrary, they go to substantiate what I have said of the nervous power as the immediate cause of the remote effects, and the importance of duly considering the special modification of the properties of life in the different tissues and organs (§ 133–152, 227, &c.).

837, *cc*. But, after all, the foregoing experiments are worthless in a practical sense, since they have been made (unless in rare and unsuccessful instances) upon a very few individuals in health; and there-

fore prove nothing as to their action upon diseased conditions (§ 137, 143, 149, 150, 152 *b*, 156, 163, &c.). And, coming to the multifarious examples in which animals have been the subjects, they serve only to raise our astonishment that educated men can have imagined their applicability, in any sense whatever, to the profound problems of human maladies. The difference in constitution alone is conclusive against the supposed analogies. It is conclusive, indeed, against all such reasoning from one species of animal to another species, however apparently allied; since, in respect to the critical relations even of food, there is scarcely any certainty attending this inductive process, while the distinction in respect to the influences of morbific and remedial agents upon different animals is marked by every agent which is capable of making any positive demonstration. Those vegetable poisons, indeed, which are most destructive to man, and to many species of animals, are to others of the brute tribe wholesome articles of food (§ 18, 150, 191, 366, 447, 854 *bb*).

838. The natural adaptation of the various fluids of the body to the several parts with which they come in contact, and the certainty with which each one produces disease in all parts to which they are not naturally related, is conclusive that the blood cannot be medicated by any agents of sufficient power to act upon parts that are morbidly irritable, without often endangering every part of the body. The principle is of course the same as with the truly morbific agents; and, to be fully comprehended, the following references should be consulted (§ 133, 136, 137, 233¾, 526).

839. As with morbific, so with remedial agents. The philosophy is essentially the same (§ 151). May we not, therefore, take from Nature an important hint as to the mode in which remedies operate, and apply it analogically to the modus operandi of morbific causes? Does unaided Nature medicate the blood? Does she ever effect a change in that fluid without an antecedent change in the solids? Never. Does she not always restore the blood from its morbid states through the agency of the solids alone? How is it with smallpox, and measles, and other self-limited diseases? Art can do nothing to shorten their established time, or affect their regular progress. Nature accomplishes the whole. But I say, again, does she first renovate the blood (§ 858, 861)? We may imagine primary changes in this fluid as the cause of the morbid changes which befall the solids; but if this were true, then, *ex necessitate rei*, the restorative powers must commence and advance with the blood. In the natural cure, however, there is no agent excepting the solids to exert the slightest impression upon that substance; by which I thus demonstrate the dependence of the morbid changes of the blood upon those solids by which their subsequent removal is brought about.

840. Try the question by an infallible experiment. Apply the medicine to the organ affected; tartarized antimony, for example, to the brain in phrenitis, to the lungs in pneumonia. How absurd the proposition! Even in the primary action of remedies upon the stomach, and when disease of that organ yields to their operation, it is not alone from the direct action of the agents, but greatly so from influences of the nervous power transmitted to the mucous tissue of the organ (§ 514 *b*, 516 *d*, nos. 6, 12, 657, 658).

Circulating within the organization, remedial agents of an irritating

nature exasperate disease far more certainly and violently than do cathartics when acting upon a highly-inflamed intestinal mucous membrane. This will be readily appreciated by all who have witnessed the stimulant effects of muriate of soda when injected into the veins of the dying subject of the cholera asphyxia. Simple as the substance, the scarce audible heart bounded under its influence beyond its natural vigor, and the whole vascular system instantly emerged from its sunken state into one of preternatural excitement, and long after the most powerful stimulants administered by the stomach would not awaken, in the least, the expiring sympathies of the heart, nor violent irritants applied to the skin rouse its circulation (§ 829).

Can it be entertained that pneumonia, or ophthalmia, or erysipelas, or furunculus, &c., are relieved by the transmission of the various substances, which may yield relief, to the very organization of the parts affected? And when vesication, and bloodletting, and mental emotions, are added to those, a medley is presented which defies assumption, but which is interpreted with consistency through the agency of the nervous power (§ 222–233$\frac{3}{4}$).

841. In former sections I had occasion to illustrate the law of vital habit by certain effects of morbific and remedial agents; and what is there considered would appear to cover the whole ground of solidism and vitalism. Among the many illustrations is the complex example of the influences of tartarized antimony (§ 549–554, 556), which may now be continued with a more specific reference to the humoral pathology, as it will be in a future section to that of its modus operandi (§ 902, *f*, &c.). Its several relations, therefore, should be regarded in connection.

I may say, then, that it is especially to my present purpose that the humoralist, as well as the solidist, is guided, in his repeated administration of the antimonial alterative, by its effects upon the stomach; since nothing can be more obvious to either than that all the remote effects depend upon the amount of impression which the remedy produces upon the stomach. It is not, therefore, quantity, but effect, gastric effect, which is regarded in the administration of this distinguished humoral agent (§ 826, *c*). The intense excitement of fever, or the violence of pneumonia, yields to the first nauseating dose of the antimonial, or if it only approximate that point of gastric irritation. The next, and the next, in unaltered doses, may fail of an equal ascendancy, while the fourth makes no resistance to the returning phenomena. But, if there be now added to the original twentieth or eighth of a grain only a fiftieth or thirtieth part, the phenomena are again subdued the moment that gastric influence begins. And in this way may we proceed, experimentally, by continuing the same, or increasing the dose, and find at each repetition that the general results will conform to the impression which is made upon the stomach, at its nearest approximation to a state of nausea; whatever the requisite dose,—however small, or however large (§ 556, 873).

Again, antimonials are more salutary when they can be borne in gradually-increased doses than where it is necessary to lessen a small dose from the beginning. The reason is this. In the first, or most advantageous case, the irritability of the stomach is not morbidly susceptible to the action of the remedy, but, on the contrary, obeys the law of vital habit in its diminishing influences upon the suscepti-

bility of the vital states (§ 551, &c.), so that the stomach is not injuriously irritated; while, in the opposite case, the law of habit has its exactly opposite effect (§ 556), and the susceptibility of the stomach being morbidly great, and farther aggravated by the antimony, disease of this organ is more or less liable to set in as a consequence, and the object of the remedy to be thus defeated. In the mean time, it may be shedding abroad pernicious influences upon other parts in doses of extreme minuteness. In a general sense, the best dose is just short of that which produces nausea; but, at other times, occasional nausea may be very salutary, and again, at others, a full emetic dose may overthrow, at once, a formidable condition of disease.

The principle, though not the details, is universal. Its practical application is of the highest importance, and, unlike the hypothesis of absorption, may be in the hands of all.

842. The *eleventh* foundation of humoralism, and the last in the order of arrangement (§ 823), is derived from the tan-yard. Thus,—animal tissues have their strength increased by immersion in astringent vegetable infusions; therefore, as many tonics are also astringent, they are taken into the circulation and give strength to the stomach and the system at large by the same process (§ 569 *b*, 904 *d*).

So much has been said upon the foregoing philosophy in the course of this work, that I should have avoided the present subject, but for its incorporation into the basis of humoralism, and as I was desirous of presenting the whole system in a methodical manner.

My own construction of the modus operandi of astringents is briefly set forth in my Arrangement of the Materia Medica, and will be extended in subsequent sections of the present work. But I would now propound for the consideration of the humoralist the modus operandi of *cold*, of *ipecacuanha*, of *muriate of soda*, and analogous agents devoid of true astringency, in arresting hemorrhage; or how sulphuric acid checks the colliquative sweat, or what would be its condition, or that of acetate of lead, on coming in contact with the circulating mass of blood? The force of necessity which applies to the answers will be very likely to extend its sway throughout the classes of astringents and tonics.

843. That nothing may be omitted which may serve to complete my analysis of humoralism, I may state what may be regarded by many as a *twelfth* fundamental ground; though it is only an induction from the general assumption that the blood is radically vitiated, &c., and the efficient cause of the morbid state of the solids. Its "black" color, as it is called, which appears in congestive fevers, scurvy, &c., is taken as one of the important evidences of its corrupted state; and when it refuses to coagulate, humoralism assumes that "putridity" has taken place. It will be thus seen that "putrescency" is only a corollary of the seventh proposition in my analysis, and sustained by the *fifth* (§ 823, 834). Liebig has gone scientifically into the subject (§ 350); and in the *Commentaries* I have endeavored to do justice to its merits (vol. i., p. 403–410, 418, 430–440, 442–460, 663–673). But, what is more remarkable than the rest, it is argued, that, because the blood ultimately becomes "black" or "putrid," it therefore takes the initiatory step in the morbid processes. It is also an important "fact" in the "experimental philosophy" of humoralism, that the color of this blood is changed to a vermilion hue by adding saline cathartics to

that which is abstracted; from which the conclusion is drawn that the same substances are taken into the circulation when administered by the stomach, and that they then and there change the color of the blood in like manner; which proves that the remedial effect is exerted upon that fluid. There is no doctrine in humoralism more strenuously maintained, and none in which the conclusions are considered more logical. It goes with the rest in representing the nature of the "experimental philosophy" which now lies at the basis of theoretical and practical medicine.

844, *a*. Finally, an author of the olden times, writing in the palmiest days of humoralism, but not of the professional corps, in one of his sallies upon the vagaries of philosophy, let slip a bolt which demolishes every material fabric in medicine.

"All the world knows," he says, "there is no virtue in charms; but a strong conceit and opinion alone, which forceth the humors (*moral* ones), spirits, and blood, which takes away the cause of the malady from the parts affected. The like we may say of our magical effects, superstitious cures, such as are done by mountebanks and wizzards (§ 197 *f*, *note*). An empyric oftentimes, and a silly chirurgeon, doeth more strange cures than a rational physician. Nymannus gives a reason: because the patient puts his confidence in him, which Avicenna prefers before art, and all remedies whatsoever. 'Tis opinion alone, saith Cardan, that makes or mars physicians; and he doeth the best cures, according to Hippocrates, in whom most trust. So diversely doth this phantasie of ours affect, turn, and wind, so imperiously command our bodies, which, as another Proteus, or a chameleon, can take all shapes, and is of such force, as Facius adds, that it can work upon others as well as ourselves. How can otherwise blear-eyes in one man cause the like affection in another? How does one man's yawning make another yawn?—one man's p—ing provoke a second many times to p? Why does scraping of trenchers offend a third, or hacking of files? Why do witches and old women fascinate and bewitch children, but, as Wierus, Paracelsus, Cardan, Mizaldus, Valleriola, Vannius, Campanella, and many philosophers *think*, the forcible imagination of the one party nerves and alters the spirits of the other? Nay, more, they can cause and cure not only diseases, maladies, and several infirmities, by this means, as Avicenna supposeth, in parties remote, but move bodies from their places, cause thunder, lightning, tempests; which opinion Alkiadus, Paracelsus, and some others approve of; so that I may certainly conclude, this strong conceit or imagination is *astrum hominis*, and the rudder of this our ship, which reason should steer, but overborne by phantasie, cannot manage, and so suffers itself and this whole vessel of ours to be overruled, and often overturned" (§ 167 *f*, *note*, 227, 234 *e*, 500 *f*, *o*, 509, 638).

845. Having now considered the grounds upon which the humoral pathology reposes, and how estranged from the institutions of organic nature, I shall proceed to offer the reader a condensed view of my argument predicated alone of the fundamental laws of physiology.

I propose showing by this argument, that the blood is neither a *primary* cause of disease in the solids, in virtue of its own morbid condition, nor an *aggravating* cause of disease when altered in its character by the morbid action of the solids.

846. No one will deny what is affirmed by Andral, that every morbid change in the action of the solids is probably followed by some change in the blood. The influences from bloodletting often give rise to very remarkable and instantaneous changes in the circulating mass (§ 952, *a–h*).

I also agree with Andral, that any *primary* alteration of the blood, of a morbid nature, must, with greater certainty, produce disease of the solids (§ 827, *e*).

The latter proposition is the basis of humoralism, and it is this which I now address.

847, *a*. There is a specious parallelism about the two foregoing propositions, of which humoralism has taken no little advantage. Both are conceded by the solidists, and humoralism draws its conclusions from both, just as has been seen of its principal data (§ 823, &c.). Its inferences involve the assumption that the blood and the solids sustain, reciprocally, the same relations to each other; when, in truth, the distinction is nearly as great as between an agent and the object acted upon. There is this difference, however. In the present case, in their natural state, the blood is the object, while it contributes to the support of the agent, and to maintain its action.

Were the blood, therefore, to become primarily diseased, it would then assume the same relation to the solids as any other morbific cause, and this the more so on account of its incorporation with them.

Now, observe the humoral premises, as laid down by Andral, and considered impregnable by all humoralists. It will be seen that the first is the very thing which is most denied in humoralism,—the ground of solidism itself; yet is it put forth for an unreflecting world. Thus:

1st. Every morbid change in the action of the solids is followed by some change in the blood.

2d. Every *primary* alteration of the blood, of a morbid nature, produces disease of the solids (§ 846).

Therefore, say Andral, and other humoralists, every morbid change in the action of the solids is occasioned by a primary change in the blood. That is the logic (§ 843). But, we have seen that the two propositions are not convertible in a physiological sense, while they stand as independent statements, and in exact opposition to each other.

But let us reverse the logic, and then see how the case will stand. By the first of the premises, the solidist argues that all morbid lesions of the blood are dependent on primary changes of the solids. And this conclusion is justified by the strongest force of analogy. From the germ to the adult, all the results of organic life have their origin in organic actions. The nutritive fluid itself, from the time that organic actions begin, is universally conceded to be either directly or indirectly the product of these actions; and the only sense in which the blood can be regarded as an agent, is that of stimulating the solids so that they shall carry on the work of life and appropriate the blood to their own uses.

Here, then, we must steadily regard the true relation of one to the other, in the farther progress of this inquiry.

Now, it is said that the solids, which give being and vitality to the blood, become, in their normal state, the subject of its morbific action; and, according to the premises of humoralists and solidists, when the solids are diseased, the blood undergoes disease in consequence.

If, therefore, diseased blood be *originally* the cause of disease in the solids, it must certainly maintain an ascendency over them. Moreover, the solids, in their turn, react upon the blood and increase the diseased state of that fluid, or the *primary* morbific cause; and, according to the admitted premises, *every increasing degree of disease in the blood must be a cause of increasing disease in the solids.* Thus would the blood and solids perpetually act and react upon each other; and since a morbid state of the blood, according to humoralism, is the primary cause of disease in the solids, and constantly becomes more and more diseased and morbific in virtue of the morbid state which it sets up in the solids, it is plain, if the doctrine of humoralism were true, there could *never be a recovery from disease.*

It follows, therefore, I say, that the solids having been brought into a morbid condition by their own natural stimulus, and their own means of sustenance, and the morbific state of the blood continually advancing, according to the admitted premises, every disease so beginning must necessarily terminate in death. For, again, in the first place, I have shown the absurdity of attempting the restoration of the blood to its natural state by any direct action upon it by foreign agents; and secondly, what I have thus shown an absurdity is a matter of universal admission, since it is conceded by all that the natural state of the blood is entirely dependent on a natural or healthy state of the solids. Nor can Nature, in her spontaneous cures, begin to restore the blood but through a primary recuperative act on the part of the solids. NOTHING, THEREFORE, CAN MAKE HEALTHY BLOOD BUT THE HEALTHY ACTION OF THE SOLIDS. Better had the chemist attempted the *manufacture* of blood, and eliminated from it an "artificial gastric juice," than the conversion of fermented, vitiated, or otherwise diseased, into healthy, blood.

847, *b.* As the foregoing doctrine is based upon fundamental laws in physiology, which admit of no "exception" (§ 284–288), it is manifest that, when the constitution of the blood is altered, or becomes diseased, in virtue of a diseased state of the solids, the blood *thus altered* is not an *aggravating* cause of disease in the solids. Indeed, should it become, under these circumstances, a direct morbific agent to the solids, the same philosophy would hold, the same effect obtain, as were the blood primarily diseased; since, as the blood is entirely dependent upon the solids for its healthy constitution, the moment it becomes a morbific agent to the solids, the latter will have lost a control which they can never regain.

847, *c.* The fundamental principles now stated might have been inferred from the final cause of the blood; since it would have been a radical defect in the animal economy, that a fluid which pervades so universally every part, which is intended for the growth and nutrition of the whole, which depends upon those parts for its being, and those, in their turn, upon the blood for their nutrition, and is at all times in subordination to the state of the solids in the natural condition, should receive a morbid impress from a part or the whole, which would not only defeat its great final purpose, but give to it an ascendency over those powers and actions to which it is entirely submissive, for the great end of life, in their natural state (§ 43, 277, 278, 303¼, 303½, 322–326, 385, 409 *f–i*, 411, 422, 424, 449 *a*, 464, 638, 733 *d*).

There is an ever-varying adaptation of the state of the blood to

the varying condition of the solids, and this is brought about by the solids themselves. It proceeds, in equal pace, with the changes of the latter; as clearly and forcibly exemplified during the operation of general bloodletting (§ 136, 970 *c*). The properties and universal condition of the blood, therefore, undergo changes corresponding with any alterations of the vital condition of the solids. What is physiologically true in this respect must be equally so in a pathological sense (§ 639, *a*). A morbid state of the blood is an exact product of an antecedent change in the solids, by which they move on in harmony (§ 653, 733 *d*, 740, 741).

847, *d*. Just so is it with the morbid product of an ulcerated surface. The exact condition of the product will depend upon the exact state of the solids by which it is generated (§ 653), nor does the product, however morbid, increase the diseased state of the solids, unless it undergo some chemical change after its elaboration. Were it otherwise, the natural and immediate result would be a perpetual increase of the morbid condition of the ulcer and of its secreted product. The same, again, is exactly true of the blood and the organs upon which it depends (§ 133 *c*, 136, 137, 150–152, 740, 741).

The analogy of which I am now speaking is still more forcible in its connections with the humoral philosophy of morbid blood, when it is considered that, with whatever violence morbid secretions may act upon sound parts, they bear a common relation to all other morbific causes, and that, therefore, as soon as the parts are brought into a morbid state and generate other or the same morbid products themselves, they cease to be offended by either. The surface upon which the syphilitic virus, or that of small-pox, excites suppurative inflammation, ceases to be offended by the virus as soon as it becomes the product of the part. Now it is, indeed, that not only is this resistance made, but Nature may set in with her recuperative process.

It is hardly necessary to add, that there is no physiological coincidence between the foregoing morbific causes and morbific blood in the humoral acceptation. The blood, in the humoral pathology, is converted into a morbific cause by agents foreign to the organic properties and actions. These properties and actions, I say, therefore, will have lost their control over the blood thus affected, since the blood is their natural stimulus, the *pabulum vitæ*, and depends upon a healthy state of the solids for its integrity.

847, *e*. The correspondence of which I have now spoken between the modified vital properties of a part and its morbid products, and between a diseased state of the solids and blood rendered morbid thereby, has its deep foundation in physiological laws. The principle is seen, naturally, in the adaptation of the veins to venous blood, the ureters and bladder to the urine, of the gall-bladder and mucous tract of the bowels to the bile, while venous blood is fatal in the arterial system, and these natural products excite inflammation in other parts (§ 133, &c., 385, 733 *d*). Mark, however, that such inflammation cannot be overcome while a fresh supply of urine or bile is brought into contact with the parts which they had thus offended. It is not now, as was just seen of the syphilitic and small-pox virus (§ 847, *d*), since no part is capable of having its constitution so altered as to generate urine or bile, and therefore there can be no preternatural adaptation of the vital state of any part to the morbific properties of those natural secretions.

And just so with the ordinary forms of disease, if excited in the solids by a primary diseased state of the blood. There will be nothing, then, to make healthy blood, and disease must go on to the death. The humoralist seems to have had some vague conception of this, since he applies himself to drugging the blood. The principle is deeply founded in organic nature, and is one of the most important in its practical application (§ 847, *b*).

847, *f*. But, again, on the other hand, in the sense of *solidism*, if the alterations of the blood depend on an antecedent morbid state of the solids, the changes of the blood will be always suited to the existing condition of the organic properties and actions, of which the morbid state of the blood has been only a consequence, as in the foregoing analogous cases (§ 847, *e*). And since the changes are thus exerted, the same organic properties and actions, whatever their condition, can, either unassisted or by the aid of remedies, replace, by their own improvement, the morbid changes of the blood by others, of any degree of approximation to the healthy standard (§ 672, 676 *a*); just as was seen of a part in relation to the syphilitic or small-pox virus.

847, *g*. Is it asked why the blood, when it becomes altered by any local inflammation, is not, according to my principles, detrimental to the system at large? The solidist can reply upon sound physiological laws, while the humoralist can make no answer.

I say, then, that all other parts are now modified in their powers and functions by the sympathetic influences of the local disease (§ 222, &c., 452, &c., 500, &c., 512, &c., 733 *d*, 811). In proportion as that affection is capable of modifying the blood, so does it exert a sympathetic effect upon all parts of the organization (§ 674, *d*). The modifications of the blood and the constitutional derangement being produced by a common cause, the blood and the solids are universally adapted to each other; the blood being thus inoffensive to the general organization, just as the virus of the small-pox is harmless to the skin by which it is generated.

This law of adaptation meets us every where, both in the natural and morbid states of the animal kingdom. It is the same great work of Design under all the circumstances of life. In disease it is coincident with what is seen in health of the modified irritability of the larynx, adapting it to atmospheric air, of the pylorus to chyme, &c. The same as the adaptation of natural bile to the natural state of the intestine, or of morbid, acrid bile to the diseased or disordered intestine. It is analogous to the expedient by which a deep-seated abscess reaches the surface, and, finally, to all the processes of recuperation (§ 156 *b*, 733 *d*, *references*). Through the same law of adaptation, also, the solids are brought into such relationship with each other by the reciprocal influences of disease as it may affect various parts, and whatever the variety in the coexisting conditions, that a single remedy, as bloodletting, a cathartic, an emetic, &c., may be universally suited to the several pathological states. These cases are perpetually before us; and were not my philosophy true, all our efficient remedies would forever aggravate some part of a compound disease. The principle is the same in both the cases, and our experimental knowledge of its truth in the latter confirms what I have stated as to the blood in the former (§ 143, *c*).

847, *h*. Were not the foregoing all-wise provisions established in

the constitution of animals, all the diseases which it may now throw off would require for their removal the interposition of Supernatural Power (§ 133 *c*, 151, 152). The morbific blood would not develop disease in one part alone, as overlooked by the humoralists, but throughout the universal organism; and the blood itself, becoming progressively diseased in the ratio of its morbific influence upon the solids, would hasten the general catastrophe in an increasing ratio. The blood of the victim of small-pox would poison more and more profoundly, while the purulent matter would erode the body and lend its powerful aid in the universal work of destruction. Nature, however, comes out triumphantly, and in an allotted time. We must look to the philosophy which I have taught for the only possible interpretation; while it opens a door to a stupendous, harmonious system of fundamental laws.

848. It will now be apparent from what has been said in the preceding section, how it is that remedial agents will call into salutary reacting sympathies various parts of the body not affected by disease, but whose susceptibilities are increased by morbific sympathies reflected from the seat of absolute disease, and upon which parts the remedial agents might otherwise be inoperative. In this way, therefore, various parts may be rendered instrumental in establishing those influences upon the seat of disease which enables Nature to take on the recuperative process (§ 137 *d*, *e*, 143 *c*, 149–151, 152 *b*, 163, 514 *h*, 674 *d*). Whatever, too, may be the complexities of disease, the right remedy will be at least compatible with the whole condition (§ 870 *aa*, 891 *g*, 891½ *e*, *f*, 892 *c*, *d*, 892¼ *c*, *d*).

849. Upon the foregoing fundamental ground (§ 847), it appears, *a fortiori*, that if perfectly healthy human blood be allowed to flow into the veins of a subject affected with fever, or scurvy, or inflammation of any important organ, in quantities sufficient to produce an effect, while, also, a corresponding quantity of morbid blood flows out of the veins, such healthy blood would aggravate the disease (§ 136, 137 *b*, *c*, *e*, 149, 152). This induction from principles has been practically demonstrated, even to the death of human subjects, although the quantity of healthy blood transmitted was small. There was no natural relation between the healthy blood and the diseased solids, and the former, therefore, became morbific (§ 152, *b*).

850. It follows, also, from the foregoing physiological principles, that morbid blood may excite disease in a healthy subject, if transferred in certain quantities into the circulation. It may be necessary, however, that the quantity should be large; when, as soon as morbid action follows, the whole mass of blood will become affected, and thus brought into harmonious relation with the diseased state of the solids (§ 847, *e*–*g*). Hence, the great mass of blood is altered from its natural state by the solids, and convalescence may, therefore, begin spontaneously, or through the intervention of art.

It is scarcely necessary to add, that the present case is entirely different from those in which it is assumed by the humoralists that the whole mass of blood is primarily morbific. The injected portion is like any other morbific agent circulating with the blood; nor does it assimilate to itself, any more than wine, or bile, when so injected, the circulating mass. The general mass remains under the control of the solids, and receives from them its deterioration should disease ensue.

Nor doss it follow that the injected blood will produce the same condition of disease as that by which it was altered (§ 350, nos. 44, 45, 97, 744, 810).

851, *a*. Finally, the humoral pathology chains the mind in ignorance, and whether with the learned man, or the bolder empyric, leads equally, in its application, to the most unhappy practical errors. The violent assumption is equally made by either, that the blood must be purified or otherwise changed by the direct action of remedial agents; that its impurities must be purged away; that the means are taken into the circulation, even calomel, blue pill, and other insoluble substances; that they are then conveyed into the torrent of the circulation, cleanse, neutralize, purify the blood, and reinstate its natural condition, as necessary to the subsidence of disease in the solids. It is all the work of the *blood-making faculty* of calomel, opium, and nux vomica. The treatment, therefore, is apt to be governed by this indication.

Or, does the humoralist resort to bloodletting; he professes to carry off the poison, the "peccant humors," &c., by abstracting some dozen ounces of blood from the circulating mass. But this is neither conformable with fact, nor with the hypothesis; since the great bulk of the poison remains behind, and since, also, at the beginning of the disease, the infected mass must be greatly less morbific than when remedies are applied at its advanced stages. The humoralist affirms, indeed, that an inappreciable quantity of miasma, or of the virus of the dissection wound, &c., enters the circulation and throws the whole mass into a ferment, and that this goes on progressively increasing; nay, that one drop of blood thus affected is sufficient to contaminate the whole mass, "as a little leaven leaveneth the whole lump," or "as one spoiled herring will taint the whole cask" (§ 350, nos. 44, 45, 821 *c*). And yet may a severe grade of disease be suddenly overcome by a single bloodletting, or by a cathartic, or by an emetic, or by a full dose of quinine.

But the humoralist, learned or unlearned, is little prone to abstractions of blood in recent times, and now, more than ever, proceeds upon the broad basis of his pathology. Cathartics are his special favorites, for they purge off the humors, and cleanse the blood; or if it be quinia for an intermittent, it is administered with a view to neutralize a poison. To him the *vis medicatrix Naturæ* is like the midnight darkness to a blind man (§ 240, 839).

851, *b*. How different the practice of the solidist; how enlarged his philosophy; how various his remedies; how consistent his doctrines; how important to humanity! Let a single example illustrate and confirm his theories. According to the nature of the predisposing causes, and the exact pathological conditions, he cures ophthalmia by an emetic, or cathartic, or by bark, or arsenic, or iodine, or mercury, or bloodletting, or leeches, or blisters, or electricity, or local sedatives or stimulants, and by light or darkness (§ 675, 686, 904 *a*).

851, *c*. I regret the necessity of the parallel and the contrast. But I speak of facts and philosophy; nor should I be true to my duty did I not speak with honesty and frankness.

THERAPEUTICS.

852, *a*. Therapeutics is the great ultimate object of all medicinal inquiries. It refers back to the natural physiological states of the body, and to the laws which govern organic beings in their healthy condition. It takes in the whole range of pathology, since there could be no rational treatment of disease without a previous investigation of its causes and nature, and a proper knowledge of their relative laws and principles. Having, also, for its specific objects the means of cure, and their just application to disease, therapeutics comprehends all the vital relations of the *Materia Medica*.

Notwithstanding, however, the vast range of principles which it embraces, and the immensity and complexity of its details, it has, essentially, but one fundamental object; namely, that of inducing such changes in the morbid organic properties and functions as will enable them to return spontaneously to their natural state (§ 177).

852, *b*. We thus find that all parts of our inquiry are intimately bound together; that together they form a perfectly consistent whole; and that as a whole each part is necessary to all the rest (§ 137 *a*, 639 *a*).

Wonderful, indeed, that so vast a subject should be so simple in its elementary principle; but more wonderful still that a principle so simple should be more complex in its attributes than all other principles in nature (§ 133–153, 177–182, 222–233).

853. It is an element of the properties of the Vital Principle that they possess an inherent tendency to return from their morbid to their natural states. This endowment has given rise to Therapeutics, and is indispensable to the perpetuation of organic beings. It belongs, therefore, to plants as well as to animals (§ 133 *c*, 185). The object of art, in the treatment of disease, is to place those properties in a condition which will enable them most readily to obey this natural tendency (§ 189).

854, *a*. Remedial agents operate upon the same principle as the remote causes of disease (§ 150–152). They can never transmute the morbid into healthy conditions. That is alone the work of Nature (§ 524, *d*).

854, *b*. The most violent poisons are among our best remedies. "*Ubi virus, ibi virtus.*" In a medical sense, however, we do not know them as poisons, but as among the choicest blessings bestowed upon man. Poisons, however, they may all become when not employed in their proper relations to disease (§ 150, 673, 674). That it may be properly known in what respects they are remedial, they should be studied in their morbific aspects; studied in their morbific effects upon diseased, not upon healthy, conditions (§ 137, *d*, &c.). Thus, also, shall we employ them with a more solemn reference to their morbific capabilities, and under the deep conviction that when injudiciously administered, they cannot fail to exasperate disease.

854, *bb*. The foregoing consideration demonstrates an important fallacy at the very foundation of homœopathy. It affects very seriously its main principle as founded upon experiments with remedial

agents upon the healthy subject. But the fact that this objection has not been advanced is an evidence of the little consideration which is bestowed upon the vast differences between the operation of remedies upon healthy and diseased organs; and if such palpable distinctions be not observed, what must be the amount of knowledge in respect to the immense variety in the degrees and kinds of susceptibility in different forms of disease and in the variable pathological states of a common form (§ 137 *d*, 150, 191, &c., 892¼ *b*, 855, 856)? There is nothing, however, more important in medicine than the principle which I am now considering. But, there can be little hope of its general recognition till experiments upon animals with a view to elicit the causes and the philosophy of disease as manifested in the human race, shall have been abandoned. Not till all indications as to the curative virtues of remedial agents shall become limited to observations upon man alone, and man in a state of disease. Not till all others shall have ceased. Not till principles in medicine are wrested from the hands of the chemical and mechanical philosophers (§ 676, *b*). Not till a proper decision can be obtained between the two methods of considering disease as propounded in sections 5½ *a*, 675, 686 *b*. Should the last of these references prevail, then must fall, as an indispensable prerequisite, all the principles and suggestions which have been derived from the philosophy which concerns the external world. and yield to that system which I have set forth as the foundation of the method of interrogating disease according to that section to which this special reference is made (§ 686, *b*).

854, *c*. In respect to the absolute influences of all remedial agents of positive virtues, they are essentially morbific in their remedial action; as will have been duly explained (§ 893, &c.). They are alterative in disease, as in health, in respect to the vital properties and actions. There is no difference in principle as to their absolute action. In certain remedial quantities, many may induce, in the healthy organism, various degrees of disease with as much certainty as those agents which are called morbific. It is upon this *alterative* nature of remedial agents that I have founded, in part, my *Therapeutical Arrangement of the Materia Medica.*

854, *d*. The difference, in principle, between the truly morbific and remedial agents is two-fold. Morbific causes make their deleterious impression, in a general sense, more profoundly and more permanently. Positive remedial agents, in certain quantities, exert such morbid changes as are not profound, and from which the properties of life may recover, by their inherent tendency, their normal state. But, there is also another difference which is fundamental. The two classes of agents not only affect the vital states in different modes, according to the special virtues of each, but each establishes changes according to the existing condition of the vital states (§ 137 *d*, 149, 150, 854 *bb*). The *Materia Medica* is necessarily founded upon the foregoing principles, however it may have been hitherto unexplained, or however it may not be now admitted.

854, *e*. In the treatment of disease, therefore, we do but substitute one morbid action for another. Nature does the rest.

854, *f*. In consequence of the laws of organization, the approximations of morbid conditions are such as to enable us to establish upon a certain combination of phenomena certain general principles of

treatment, corresponding harmoniously with the principles through which the morbific agents have induced the adverse changes. The curative principles, therefore, will be liable, in all cases which are not exactly alike, to certain modifications according to the modifications of disease; and these are to be learned, especially, from the vital manifestations (§ 150–152, 177–179, 182 *b*, 638, 650, 670, 672, 676, 677, 680, 733 *e–i*, 741 *b*, 745, 756 *b*, 758, 766, 854 *bb*).

855. Many of the remedies for disease, especially when Nature is engaged in the recuperative process, consist of the ordinary means of maintaining health, such as the various modes of exercise, change of climate, &c. These means now operate with greater power than under circumstances of health, and must therefore be carefully adapted to the existing state of the patient, since, when unduly applied, they aggravate or reproduce disease like agents of absolute virtues (§ 137 *b*, 143, 147, 149, 150, 854 *bb*, 872 *a*, 902 *m*). When productive of useful effects, they co-operate in a direct manner with the tendency to restoration which had already begun (§ 672).

Of the same nature, also, are the agreeable excitements of imagination, of society, of rural scenery, of joy, hope, amulets, charms, &c. While, also, some of these means may be powerfully morbific, they may be equally curative of disease (§ 226, 227, &c., 844).

856, *a*. There are yet other remedial means which may be called negative, or such as merely allow Nature the fullest opportunity to go on with her recuperative efforts. They make no impression upon the vital conditions; and all the changes to which they administer grow exclusively out of the constitutional tendency of the properties and actions of life to return to a state of health. They consist, therefore, merely in removing or withholding the exciting causes of disease.

856, *b*. Now the means of cure embraced in this and the preceding sections are of the highest moment in every case of disease; and yet are they the most neglected except by those who depend on Nature alone (§ 854, *bb*). In a large proportion of chronic forms of disease, and where they are acute, but not profound, little else is needed than a modified system of hygiene adapted to the individual cases. Coming to graver modes of disease, and where active remedial agents are required, the negative means are more important than in the former cases, and nothing more so than a rigorously low diet.

Here, then, is opened a wide door for the contemplative and practical inquirer. Here recuperative nature is displayed according to the Ordination of Providence throughout brute creation. The animal sickens, "starves," and thus nature works the cure. Man alone violates her law.

857. It has been seen that morbific and remedial agents, even the natural agents of life, acting with certain intensities, and under given circumstances, may be entirely on a par; each leading with certainty to morbid changes which may transcend the restorative efforts of nature.

This fact involves a principle which is fundamental in the Materia Medica; that of limiting the quantity of remedial agents, and the duration through which they operate, so that they shall only establish such changes in the vital conditions as will enable them to exert their fullest tendency to return to a state of health. Beyond that point, positive remedies determine morbid changes that are embarrassing to

Nature, and may be far more so than the conditions which had been instituted by the primary cause of disease. This is a matter of constant demonstration; and if we connect with it the more general abuse of food, their common mode of action becomes so obvious, that he who may pause in his excessive medication should take the hint and unite the advantages of the negative treatment (§ 856).

I am now upon ground of the first importance in practical medicine. I have endeavored to enforce and to illustrate that importance by calling up, in a variety of shapes, those fundamental physiological laws which give the greatest determination to the effects of remedial agents, in respect to their amount, and the frequency of their repetition (§ 889, *l*). I leave out of consideration, for the moment, the vast questions which relate to the right adaptation of remedies as concerns their nature, and the order of their application (§ 150). I would dwell abstractedly upon the *dose* and the *frequency of its repetition.* Too little reference to the natural constitution of the properties of life and the laws which they obey in their natural states, and too little dependence upon recuperative nature—ay, I may safely affirm, too general an abandonment of that foundation, and even a universal ignorance of the practical bearings of some of its most important elements (§ 516 *d*, no. 6, 524 *d*), have mainly led to an abuse of remedies in respect to doses and their repetition, which has been more pernicious than errors in their appropriate nature, and their order of application. That abuse, indeed, in connection with the stimulant and feeding practice, is the whole secret of the origin of homœopathy, and of its temporary prevalence in some foreign countries (§ 621, *a*).

It must be conceded, however, that there is no attainment in medicine so difficult as that which relates to quantity or dose, or which requires so much critical observation of disease; and next to that is the time when the dose should be repeated, or varied, or some substitute made. The most delicate points are relative to dose and repetition, and these can never be attained with any accuracy without a full appreciation of certain physiological laws which I have endeavored to expound as far as my own apprehension of their nature will admit (§ 5½ *a*, 516 *d*, no. 6, &c., 686). It should be kept steadily in view that all efficient remedies are morbific in excessive doses, that what would be perfectly inert in one condition of the same disease may be fatal in another modification, and that the impressions produced are continued beyond the time of their direct operation, according to the nature of the remedy, its dose, the precise pathological conditions, &c. (§ 149, 150, 163, 191, 514 *g*, 516 *c*, 516 *d*, no. 6, 550, 552, 556 *b*, 558 *a*, 673). A repetition of the means before the influences already established shall have ceased, or have duly lessened, or have fallen short of the intended amount, either prolongs the cure, or exasperates and multiplies disease (§ 872).

858. The foregoing principle is strikingly shown, and a large reliance upon Nature as strongly enforced, by the impracticability of art in arresting the progress of the self-limited diseases, and by their spontaneous termination in health. We cannot, by any active treatment of small-pox, &c., place the morbid properties and functions in a more advantageous state to exert their recuperative principle than had been already done by the very causes of the disease. On the contrary, all active treatment embarrasses Nature, and is generally mor-

bific. Accidental conditions, such as inflammation of important organs, may spring up in the truly self-limited diseases, which may require a decisive impression from remedial agents; and it is an admirable law of nature that, in proportion as these special exigencies may arise, the influences of their pathological conditions will enable the more general affection to bear the treatment that may be demanded by the contingent derangements (§ 150, 156 *b*). But we must be careful to avoid such agents as may interfere with the established tendency of the general affection to subside spontaneously.

Nowhere, however, is the recuperative tendency of nature, the *vis medicatrix naturæ*, so forcibly displayed as in the brute creation, where instinct alone obtains, and where organic life moves on unshackled by artificial habits (§ 856, *b*).

859, *a*. We see, therefore, more and more, that, in therapeutics, we should cautiously avoid those fallacious inductions which have been drawn from the action of remedial agents upon man in health, and even upon animals and plants, and which constitute a part of the "experimental philosophy" of the age (§ 854). It is, however, one of the worst corruptions that has crept into medicine. I have variously indicated its want of philosophy, and the evils of its practical application. They are summarily comprehended in principles set forth in sections 149–152. These principles I regard as among the foremost in therapeutics; and here, but for other reasons, they would have been first announced.

859, *b*. To arrive at any just knowledge of the physiological relations of any remedy to a given form of disease, it must be considered in the opportuneness of its application, its appropriate degrees, and according to the varieties of constitution, age, habits, sex, &c., and according, also, to the nature of the affected organ, to the variations of any given disease, its sympathetic influences, and as those influences may be modified by the remedy, and the connection of the particular remedy with other agents that may precede, or follow, or be simultaneously employed, and all other circumstances that may favor or embarrass its most salutary effects (§ 133–163, 535, &c., 574, &c., 585, &c., 622, 650, 651, 659–662, 671–673, 675, 685, 686, &c.).

859, *c*. Nevertheless, the salutary action of remedies, or rather the aid which they may contribute to the recuperative process, is commonly in the ratio of the intensity of disease. This grows out of the constitutional nature of the organic properties, as already variously considered.

860. All remedial agents of positive virtues, like all morbific ones, alter the properties and actions of life, *cæteris paribus*, according to the nature of each agent (§ 652). Each one affects them in *kind*, and in a way more or less peculiar to itself. Hence, mainly, the varieties in any common genus of disease, as in inflammation and fever; hence, also, the modifications of a common mode of treatment, and hence the importance of selecting the cathartic, the emetic, &c., whose virtues may be most appropriate to the precise pathological condition of the case before us.

861. There are but a few diseases which have a determinate tendency to a state of health, and these are, in consequence, denominated self-limited. Sooner or later, however, there is apt to arise in a large proportion of diseases a spontaneous subsidence. This may not be

true of a great proportion of cases; but the restorative disposition is often manifested in a great number of instances of any given disease, while a greater number of the same disease may run on to a fatal termination. Their morbific causes are not such, as in small-pox, &c., as to establish modifications of the vital states which go on through regular changes, till they terminate in health (§ 858); though there may be a strong tendency of this nature existing, as seen in intermittent fevers. New agents (called remedial, but in reality morbific (§ 901)) may, therefore, be made to operate so as to develop the restorative principle where it might otherwise fail, or introduce it sooner than it would occur spontaneously; and thus place the disease on a par with the self-limited, whose predisposing causes surpass all remedies, in a fundamental sense, in developing a tendency to the restorative process.

It is also important to consider that the restorative process, in a general sense, is most readily established near the invasion of disease, whatever its violence (§ 557 *a*, 868, 869, &c.).

862. Nature resorts to a variety of expedients in carrying out her process of cure. The principle is the same in all the cases, and its details illustrate what has been hitherto so obscurely meant by the *vis medicatrix*. It is the same, through all the intermediate conditions and complications, from those diseases which are marked by a definite order of results, as in the self-limited, to the most intractable maladies. A clear and impressive example of the nature of the principle is seen in the progress of an abscess toward the surface, to its termination in health (§ 733). Whenever inflammation passes its formative stage, there is always some sensible demonstration of the *modus operandi* of the *vis medicatrix*. These visible results are of a depletory nature, like redundancies of bile, and consist of lymph, serum, pus, &c.; and, although the results of salutary changes in the morbid states, and conducive to the farther subsidence of disease, they are apt to constitute as great or greater evils than the disease whose decline had led to their formation (§ 732 *d*, 733 *a*). It is the business of art to prevent these intangible consequences, although they grow out of a law by which Nature aims at preservation and cure (§ 733, *e*).

863, *a*. In the treatment of disease we endeavor to imitate Nature in her spontaneous efforts at relief, so far as principle is concerned. If these efforts result in the formation of new products, or an increase of the natural ones, in certain modes of disease, our remedies should be such, in the same, or analogous affections, as will be likely to determine an increase of the natural secretions (§ 732 *a*, *b*, 756 *b*, 785, 801, 805). And, although these effusions do not relate directly to the parts that may be mainly diseased (as is generally, though not always, true of Nature), they are significant that favorable impressions are made upon these parts. In the natural cure, also, it is these vital changes, far more than the physical products to which they give rise, that determine the cure. This is artificially exemplified in the influence of vesicants, rubefacients, issues, moxa, &c., upon deep-seated inflammations.

863, *b*. Nevertheless, these redundant products, whether of Nature or of art, contribute more or less, as means of depletion, to the restorative process. The part, however, which they perform will depend upon a variety of circumstances, upon the nature and seat of the

disease, upon the means employed by art, upon the organ from which the effusion takes place, and whether from that which is diseased or from another which may only sustain a moderate sympathetic derangement, upon the nature of the product, and whether it be the consequence of disease or induced artificially.

863, *c*. If Nature institute the effusion, it is commonly far more curative than when flowing from remedial agents. The latter operate mostly by changing the morbid states; and although they are designed to imitate nature in their general results, they may be yet intended to prevent many of the consequences of spontaneous cure, such as effusions of lymph, serum, and blood, and the formation of pus. But, in accomplishing this, they institute an increase of those natural products which issue upon open surfaces (§ 662).

863, *d*. The increased product is most curative when it proceeds directly from the affected organ. This is true both of Nature and of art. If produced artificially from other organs, the curative effect will be generally the greatest in proportion to the importance of the organ; but the main effect will be now due to sympathies reflected by the vital changes which give rise to the increased product; as when cathartics augment the bile, the intestinal mucus, &c., or antimonials the perspirable matter. Hence, it will be seen that the vital changes induced will depend, in any given form of disease, upon the nature of the cathartic by which the bile or intestinal mucus is augmented. Calomel, or jalap, or castor oil, &c., may be speedily curative, when aloes, or elaterium, or croton oil, &c., may be as speedily fatal. So, again, as to "sudorifics," as they are called. Antimonials or ipecacuanha, for example, though they but soften the skin, may overthrow the most profound inflammations, when hot water, or herb teas, would be perfectly inefficient, though they bathe the skin in perspiration. "Sialogogues" fall under the same philosophy. Horseradish is one of them; but though its mastication may keep up a flow of saliva, it will only aggravate an inflammation which mercury, without salivation, may soon subdue. We come thus to understand how all remedial and morbific agents affect the vital states in conformity with the exact virtues of each agent and the existing condition of parts upon which their effects may be exerted (§ 150). We are thus enabled to understand why the vomiting which is produced by an offensive odor, or by tickling the fauces, or by disgusting objects, or any other mental emotion, or by warm water, is less effective in breaking up disease than when produced by an infusion of mustard seed; and less from the last than from the sulphate of zinc, and less from this than from ipecacuanha, and often, perhaps, still less from ipecacuanha than from tartarized antimony, and perhaps often still less from either than from ipecacuanha and tartarized antimony combined. One agent impresses the organic properties of the stomach more profoundly and in a different way from another, and therefore excites and modifies the nervous power in a way peculiar to itself, which, when transmitted to the diseased parts, will affect their condition in modes corresponding with the peculiar impression that had been made by the nauseating influence exerted on the mucous tissue of the stomach (§ 226, &c.). And so of every other remedial agent which produces its effects upon remote parts by primary impressions upon the gastro-intestinal mucous membrane, or the skin, or any other organ. The same is also equally true of mor-

bific agents (§ 650, 653). And here, through the foregoing philosophy, we may understand the reason for the differences in results between the action of cathartics, and the analogous effects of emetics upon the intestine. We may regard it, for example, as manifested by tartarized antimony, in the double aspect of a curative and morbific agent as it may happen to prove emetic or cathartic. If it fail of the former effect, it will, nevertheless, have produced more or less of that profound impression upon the stomach which is peculiar to its own virtues in their relation to the gastric mucous tissue, and when it passes on to the intestine, it exerts not only a more depressing effect upon the whole organism, but may act upon the intestine as a profoundly morbific cause, and send abroad morbific influences that light up inflammation in the lungs, or extinguish life, as is often the case, ere its purgative effect has ceased (§ 150, 226, 228). The fundamental principles are the same throughout, and there are none of greater importance in medicine. No chemical, physical, or humoral hypothesis can withstand its force, for a single moment, with the enlightened practitioner. In a practical sense, it should be the perpetual study of physicians; the touch-stone, as it were, by which all remedies are selected (§ 149–154, 500 *n*).

A great variety of other practical conclusions follow in the train of the foregoing principles. We see, for example, from what is known of the rapidity with which emetics produce vomiting, and the reaction which speedily follows, that they exert their alterative effects upon diseased parts with great suddenness, and that the influence of merely nauseating doses of the same agents may exert their effects more gradually, and may therefore, according to the nature of their virtues, be more profoundly alterative. The nausea, therefore, which precedes the emetic effect of tartarized antimony may be remarkably productive of an alterative influence upon all the organs of the body (§ 514, *h–m*); prostrating the circulation, and, when prolonged, removing croup, or pneumonia, more effectually, perhaps, than by the speedy operation of an emetic. Hence, also, it is obvious that emetics are mostly useful, in their therapeutical aspect, soon after the invasion of disease, when unembarrassed by the force of vital habit (§ 535, &c.), or during the intermissions of fever when nature is inclined to the restorative process, and when, as in either case, she may require only a sudden and temporary shock to place her permanently in the right way. The philosophy of their success in these cases, therefore, is perfectly simple. The morbid change, in one case, having but just begun, and Nature, in the other, being inclined to restoration, the sympathetic influences which radiate from the stomach, during the action of an emetic, easily establish new changes in the diseased conditions, when the properties of life are enabled to obey, at once, their natural tendency to return to a state of health. This simple principle, therefore, leads us to understand that the most auspicious time for administering an emetic in intermittent fever is when the stage of intermission is fully formed. There is now the greatest suspension of morbid action, and the organic states are going the right way. We therefore seize this moment to prevent Nature passing again into a state of incubation; or, perhaps, a better time is not long before the expected access of a paroxysm, since the artificial change being made about the time of the access, the predisposition is so crippled at this particular

juncture that the artificial change breaks up, most effectually, the succession. This interruption of the access of a paroxysm destroys the paroxysmal habit, and the disease is at an end. The same philosophy is here concerned as that which respects the influences of bloodletting just before the access of the cold stage, and goes to illustrate the modus operandi of that remedy (§ 986, &c.). But the most advantageous time for bleeding, if not demanded by some inflammation, or by high arterial action during the access of the hot stage, is soon after that stage begins to subside; and this, next to the time just antecedently to the expected access of the cold stage, is the best period for administering an emetic; and this, also, is the best period for the exhibition of a cathartic, unless given along with the emetic before the access of the cold stage. The same philosophy applies, whether Nature be engaged in a restorative movement, or be about to enter upon a state of incubation. The expediency as to time depends upon the kind of remedy. In either case, Nature may be readily turned into her favorite course. Conditions are instituted which correspond with those through which the morbid properties take on spontaneously the progressive changes that result in health; as shown by the coincidence in the immediate results of the remedies, and those which ensue at more distant times when no remedies have been applied. In either case, whether the artificial or the natural, sweating breaks forth, the secretions of the liver, of the intestinal mucous tissue, of the kidneys, &c., are poured out. By anticipating nature we aid her in consummating her efforts at relief; while the artificial change so far transcends the spontaneous improvement, that Nature is greatly started along in her recuperative process, and often obtains an impulse by which she passes on triumphantly through an uninterrupted series of salutary changes, till the properties and actions of life become restored to their natural state (§ 672, 675). And here we may look at one of the reasons why cathartics are more remedial than emetics after disease becomes established; for, although the most profound sympathetic effects may be determined by emetics through the mucous tissue of the stomach, the impression upon that organ, as exerted by the most curative, is much more transient than that upon the intestine by the best of the cathartics (§ 514 *g*, 516 *d*, no. 6). This, however, is only a principal one among other reasons, of which the difference in *virtue* is the greatest. Hence, an important corollary, that the therapeutical effects of cathartics and emetics, and, indeed, of all other remedies, will depend, other things being equal, upon the particular virtues of the agent, and the time, within certain limits, during which it may act upon the gastro-intestinal mucous tissue.

We may remark, also, as intimately related to the principles and practice now under consideration, and as farther illustrative of the importance of adapting our remedies to the precise pathological condition of any given form of disease (§ 675, 870 *aa*), that cathartics, unless united with an emetic, are apt to be detrimental if exhibited just before the access of a paroxysm of intermittent fever, and to bring on the attack. But this is less the case with an appropriate cathartic, such as calomel and jalap, if associated with an emetic; since the operation of the cathartic is then more immediate, less prolonged, and its general irritation more or less counteracted by the prostrating effect of the emetic. It is the same principle which is concerned when

antecedent loss of blood lessens the constitutional irritation of cathartics, or when the prostrating effect of an emetic prevents the abstraction of blood, however apparently different in the two cases. The principle reaches very far into the philosophy of medicine, and concerns, especially, the order in which remedies should be applied. As one of its more obscure details, I may say that the union of opium with a cathartic, for the purpose of moderating the irritation of the latter, is exactly equivalent to either of the immediately preceding examples.

From what has been just said, we readily see one of the principal distinctions between cathartics and emetics. The non-stimulant emetics, I say, lessen or prostrate, at first, the organs of circulation throughout their widest range, establishing perspiration as a consequence of salutary changes, while, on the contrary, cathartics are more or less apt to stimulate and excite the circulation at first, and do not often affect, in a sensible manner, the functions of the skin. A knowledge of these differences, as well as of the analogies which prevail among the influences and results of different remedies, and also of their modus operandi, is indispensable to a successful application of those suggestions which are afforded by Nature in her unaided efforts at restoration.

863, *e*. In respect to the curative influence of increased effusions, much will depend upon the intrinsic nature of the product which artificial or natural changes may bring about (*b*). By the natural process, in local inflammations, lymph, and serum, and pus are a good deal alike in the amount of effect (§ 732, *d*), and redundancies of bile are next in the relief of hepatic derangements. Least of all, in respect to organic products, is increased mucus. But this will depend much upon the nature of the part. It is most curative in inflammations of the lungs, far less in intestinal inflammation, and still less so in inflammation of the bladder (§ 133, &c.). The inorganic products contribute very little, by their augmentation, to the curative process, whether naturally or artificially induced. Perspiration is more so than urine. When these products, however, flow abundantly, the salutary effects depend mostly upon the vital changes from which the redundancies emanate. Humoralism, on the other hand, imputes all to the augmented product (§ 514, *h*). That is the difference between solidism and philosophical humoralism. The former detects the cause and renders it his polar star in his philosophical and practical movements; the latter mistakes the effect for the cause, analyzes the blood, or the saliva, or the urine, and according to the real, or artificial, or imaginary developments of the test glass and crucible, he neutralizes an acid or an alkali, purges off ozmazome, or picromel, or cholesterine, and taps the abdomen to cure the dropsy; while the charlatan "holds up the mirror," and all the world believes the shadow reflected "Nature" (§ 5½, 349 *d*, 851).

863, *f*. But Nature has one means of depletion which stands for all the rest. And so it does in the hands of art. This, I need not add, is loss of blood. Here Nature and art meet upon common ground. Both interpose the remedy for the direct subversion of disease, and both equally prevent thereby the formation of other products (§ 805, 890 *d–g*, 1019). Indeed, such is the magnitude of this remedy, and such its direct effect in changing pathological conditions, that I shall enter largely upon the philosophy of its operation, and its applicability to disease.

863, *g*. What we have now seen of Nature and of art, in respect to inflammatory diseases, is equally true of fever. The effusions, however, which Nature institutes in fever are less various than in inflammation, and proceed from organs connected with the external world. But here they are more universal, and it is here as fever is complicated with venous congestions that Nature makes the same demonstration with the *remedium principale* as she does in obstinate affections of the lungs, or the stomach (§ 805).

863, *h*. It is a common event for disease to persist until great emaciation, and other signs, denote approaching death, but, notwithstanding, for the restorative process to set in, and where no secreted products had apparently contributed to the change. In these cases, however, the emaciation has been more or less an equivalent. And here, again, a lesson may be taken from Nature, on the subject of diet, by those who will not listen to her law as proclaimed by the instinct of animals. But even where disease is maintained by errors in food, there may be yet remaining hope from emaciation.

864. It appears, therefore, that the salutary changes which occur spontaneously in all inflammatory and febrile affections lead to a variety of evacuations from the secretory and excretory apparatus, and within the organization, of which effusions of blood are the most efficient. Art, in its imitation of Nature, has proved that she is the only guide ; and since fever and inflammation comprise all the severe forms of disease, and as there is nothing in the results of spontaneous changes which correspond with those induced by tonics and stimulants, we may safely conclude that those practitioners who often resort to that class of agents have but very imperfect views in physiology and pathology, and are astray from the path of Nature.

865. No remedial agents are truly specifics; though, for conventional purposes, the designation is useful. Mercurials will often fail of curing syphilis, where a non-stimulant diet may succeed alone. Cinchona may exasperate an intermittent, when arsenic or cobweb would readily succeed. There is no remedy, indeed, however adapted to the cure of any given disease, which will not sometimes fail, and admit of a substitute apparently quite different. Bloodletting, cathartics, &c., will generally remove intermittent inflammation; but cases occur in which the special *febrifuge* virtue of cinchona is necessary.

866. All remedies, therefore, are only so in relation to diseases upon which they may exert salutary effects (§ 149, 150). Cinchona, for example, is a remedy for intermittent fever if no local diseases of severity exist; but if so, it will commonly exasperate the fever, and is then a morbific agent (§ 854, 857). Its *tonic* virtues then transcend its *febrifuge*.

The former of this remarkable combination of virtues may be the best for enfeebled states of the system, or of the stomach, if no inflammation be present; otherwise, it is morbific. It should be constantly before us, that a tonic, an antiphlogistic, &c., are only such when appropriate to the case before us. With this understanding, we are led to investigate the exact pathology of the case, and its various attending circumstances (§ 673, 675, 685, 686).

867. The curative effect of remedies is more or less progressive. When the primary state begins to give way, a new pathological condition is introduced, and so on in regular progress where there is an

uninterrupted decline of disease (§ 672). But it rarely happens that diseases are diverted from the essential pathological character with which they begin.

The curative effect commences at the first moment a favorable impression is made upon the seat of disease or upon any part capable of participating sympathetically in the restorative process, and terminates when that exact change is made in the diseased properties and functions which is most conducive to their spontaneous recovery. When remedies are carried beyond that point, they are apt to become morbific. Hence it is one of the most important, but difficult acquisitions, to determine when our remedies should be discontinued, or moderated.

868, *a*. It should be a great object of art to render the associated train of pathological states as short, and make it consist of as few changes, as possible. In a general sense, therefore, where disease is intense, the first remedial impressions should be strongly made ; but, in doing this, the right agents should be selected. It would answer, for instance, to exhibit a decisive dose of calomel and jalap, at the onset of pneumonia ; but it would be sad practice in inflammation of the intestine. Bloodletting, however, is adapted to either case, and is the right initiatory remedy for both.

As the favorable changes advance, our remedies should become milder and milder, till that critical point is attained where Nature requires only the occasional interposition of art to accomplish the removal of some slight obstacles that are more or less liable to spring up during convalescence; such as constipation, deficient secretion of bile, &c.

868, *b*. Our remedies may be perfectly right, and yet disease shall increase by the force of its intensity (§ 685, no. 9). In such a case, however, we may have fallen short of the due amount of the remedial agent; and this we shall see to be often true of bloodletting. But it is rarely so of any internal agent; there being a prevailing disposition to medicate largely. We have thus a positive abuse of drugs and a negative abuse of bloodletting. Being sure of the right, we should steadily pursue it; repeating the remedy, or associating, or substituting, others of analogous virtues in relation to the case before us, till their effects are pronounced by a manifest decline of the symptoms.

869. The rapidity with which the full salutary changes will be effected, will depend upon a variety of circumstances; but mainly upon the period of the disease. All diseases being most easily and speedily arrested near the time of their beginning (§ 557, *a*), the difficulties increase in proportion to their unmitigated duration, or any increase they may sustain. They soon begin to acquire the obstinacy of a morbid habit (§ 535, &c.), to involve sympathetically other organs, and to result in disorganization, effusions of serum, &c. (§ 660, 712–718, 732 *d*).

870, *a*. Some remedies, in their greatest proper latitude, make a decisive impression much sooner and more effectually than others, under the same circumstances of disease, and where either may be appropriate. Bloodletting, in inflammations and fevers, operates far more immediately and decisively than any other remedy, and cathartics are generally next. And so of many individual cathartics which may be appropriate to a given condition of disease. The saline may be slowly and moderately useful, and some of them better than oth-

ers; castor oil more speedy and effectual; jalap more so; calomel far more so; and the united force of calomel and jalap may greatly transcend either. Sometimes, however, as we have seen, a fever at its onset may be completely subdued by the alterative action of an appropriate emetic. Tartarized antimony will do it with the greatest certainty; ipecacuanha comes next; but most of the other emetics would be perfectly useless or detrimental. The union, however, of antimony and ipecacuanha improves the useful *alterative* virtue of each, and lessens the chance of morbific action from the antimonial (§ 150).

870, *aa*. Remedies sometimes operate with great and rapid effect upon one part of a compound disease, but may fail in respect to other parts; or, if not justly applied, they may assuage a part of the disease, but, from their want of proper relation to other parts, they may prove morbific to these conditions, and thus indirectly reproduce that part of the malady which they had been instrumental in subduing. But this will not happen with the right remedy (§ 150, 552 *d*, 665, 848). Bloodletting, for example, may quickly subvert pneumonia when complicated with small-pox, but will not shorten the natural progress of the more general malady (§ 858). But the remedy will now be perfectly compatible with the whole condition of disease; since the local inflammation has brought the specific form under its influence, and bloodletting now operates in conformity with the law of adaptation (§ 137 *c*, 143 *c*, 847, &c.). Through the same law quinine may be peculiarly salutary in some cases where pleurisy is complicated with small-pox, if the former affection be owing to the remote causes which generate intermittent fever; but will exasperate the whole condition of disease if the pleuritic affection be owing to any other cause. Much, also, may depend upon a coexistence of different virtues in a remedial agent, especially in connection with the amount of its doses. Thus, quinia, in the dose of five or ten grains, may speedily arrest an intermittent fever by its *febrifuge* virtue. But that is bad practice; since, by its associate *tonic* virtue, it is likely to increase or to induce local congestions; thus leaving the patient imperfectly cured and subject to relapses (§ 769). But, in these cases, the local inflammation and venous congestion are so apt to be modified by the predisposing cause of the febrile affection, that repetitions of a small dose of quinine may be curative as to the whole condition of disease. I have twice seen, in my own family, the most formidable grade of remittent fever, of long duration and attended by the foregoing complications, ardent heat, thread-like pulse, loss of mind, &c., and where hope of recovery had been abandoned, yield to less than a grain of quinine, divided into sixteen doses (§ 137 *d*, 662 *b*, 756, 811, 813 *b*, 857).

870, *b*. This leads me to say, that the best experience sustains what is enforced by my interpretation of the modus operandi of remedial agents, that simplicity of treatment should distinguish the course of the practitioner. Where diseases are circumscribed, he will have little need of variety; while, on the other hand, the more compounded the affection, the more likely will it be necessary to bring several agents into operation. In simple pleurisy, an appropriate loss of blood may be the only requisite means, and an emetic at the invasion of croup. But if pleurisy be complicated with congestion of the liver, or with idiopathic fever, &c., several other agents may be necessary to meet these complications. Much, however, will depend upon

the stage of the disease when the treatment is begun. There must be harmony, however, among the virtues of the several agents, conforming to the general modifications of disease, and the existing susceptibilities to their influence (§ 150, 870 *aa*, 871, 888 *b*).

871. We have variously seen how the susceptibility of organs to the influence of remedial, as well as morbific, agents may be increased by antecedent impressions from other causes (143, 145, 149, 150, 556, &c.). This is fundamental in therapeutics, and carries us back to preceding statements (§ 672, 867, 868). The administration of remedies proceeds greatly upon this principle. One prepares the way for the favorable operation of another, or which last might be otherwise injurious. A remedy which is curative under one combination of circumstances may aggravate disease when that combination is a little varied. The cathartic which would not irritate intestinal inflammation immediately after bloodletting, might greatly exasperate the disease if exhibited without the antecedent loss of blood. And so of vesicants, &c. Indeed, so profoundly and rapidly curative is bloodletting of inflammatory affections, and so greatly does it promote the useful effects of other remedies, or arrest their morbific action, that, whenever it is indicated, it should precede all others; and then it will be often found that it has taken the place of all others.

Hence a great doctrine in therapeutics, that the order in which remedial agents are applied should be in their best individual relations to the existing pathological state, whether that state may depend exclusively upon the primary causes, or as modified by the subsequent treatment (§ 137, *d*, &c.).

This principle, however manifest, enforces a thorough knowledge, not only of physiology and pathology, but of the exact capabilities of remedial agents, of their various doses, and of their modus operandi, in any given pathological state. Its highest practical attainment is the highest consummation of medical skill and science. It is the *ne plus ultra* of medicine (§ 857).

872, *a*. The last section involves the principle which is concerned in the combination of medicines. By the union of two or more, and according to the exact virtues of each substance, and according, also, to the proportion of each, we create, as it were, a new remedy,—add a new one to the Materia Medica. It is thus seen that art may multiply remedial agents to an almost endless extent; and this explains the reason, in part, why the most enlightened practitioners do not often seek for desirable virtues in the inferior medicines. By variously combining two or more of a limited number, new virtues are evolved, however analogous, in almost every prescription for disease.

By this process, what might be otherwise highly morbific may be rendered curative. The cathartic, which given alone might aggravate intestinal inflammation, may be often rendered safe and useful by the addition of a little opium or hyoscyamus; and thus, too, the necessity of antecedent bloodletting may be sometimes avoided. The narcotic so lessens irritability that the cathartic is innoxious, and is thus enabled to establish a favorable pathological change. How adverse to humoralism this single example, how confirmatory of the doctrine which I have taught of the action of remedies upon the properties of life (§ 188 *a*, 189, &c.)! Add to the cathartic, guarded by the narcotic, a grain, or more or less, of ipecacuanha, and new alterative

influences may spring up, of great power and extent; each ingredient, and according to the proportion of each, modifying, increasing, and extending the alterative action of each, but in such a combined manner that the compound acts as a whole, and not by its individual parts (§ 188½ *d*, 514 *h*, 889 *k*).

Take another example; for these examples not only illustrate important principles, but are, in themselves, practically important. In a case of common remittent fever, near its invasion, we may proceed with decision, employ bloodletting, calomel and jalap, and speedily pretty well overcome the disease. The most that the patient will immediately afterward require will be rest, low diet, and mild influences by certain cathartics. The best of these, till the bile begins to assume a good yellow color, will be small doses of castor oil; for this cathartic exerts a peculiarly alterative influence upon the liver. When the dejections shall have put on a natural aspect, castor oil begins to irritate the intestine rather injuriously, and this effect increases as its repetition goes on; although given, perhaps, in the dose of a tea-spoonful, or a half tea-spoonful only, to an adult. It is also then apt to nauseate the stomach and prostrate the strength. Convalescence has now advanced too far for this active agent, and some other should be substituted to maintain a free secretion of bile, and to procure one evacuation, at least, daily. Now, I know of no mild cathartic which is exactly suited to this state of things. If we employ moderate doses of Rochelle salts, they operate too superficially; mainly upon the mucous tract of the intestine, and are also apt, in this condition, to irritate that membrane injuriously. Magnesia is liable to the same objection as it respects the superficial effect; and rhubarb alone is too stimulating to the whole system, and to the mucous tract. But it has the advantage of extending its influences to the liver, and of promoting the tone of the stomach and of the whole system, when this part of its tonic and stimulating effect can be properly restrained.

Now, the foregoing three agents in combination, and in proportions adapted to the state of the case, are exactly suited to the convalescent from fever, who has passed the stage when castor oil ceases to be useful. The magnesia corrects the irritating effects of the Rochelle salts, and neutralizes any acid that may exist in the primæ viæ, while each counteracts any injurious stimulant action of the rhubarb, so only the proportion of rhubarb be not too large. The rhubarb, also, in its turn, gives tone to the digestive organs, counteracts the prostrating effect of the saline substance, and imparts to the whole compound a sympathetic influence over the liver, by which a free secretion of bile is maintained till health is established.

Nature has carried out this principle of combination very extensively, and has thus supplied, in numerous substances, a variety of virtues in each one, which are exactly adapted to the varying exigencies of disease. We see it strongly pronounced in the cathartic, tonic, and astringent properties of rhubarb; in the febrifuge and tonic virtues of cinchona; in the soporific, anodyne, and relatively astringent properties of opium; in the narcotic and laxative virtues of hyoscyamus, &c., Indeed, so manifold is this union of virtues, that art has availed itself of the opportunity, and elaborated many in the form of the alkaloids, &c., by which greater simplicity is obtained.

It is not unusual to meet with prescriptions in systematic, labor-

saving works, embracing several articles, with definite proportions of each, which are said to be adapted to certain forms of disease. This practice is not only wanting in philosophy, but is clearly empyrical; since the adaptation of remedies, both as to the ingredients of the compound, and their relative proportions, should be adjusted by the united circumstances of every case, as they may exist at the moment; especially in all the forms of acute disease. It is manifest, therefore, that this great object of medical science can be fulfilled only by a careful investigation of every case whenever a prescription is made. It implies a great range of inquiry, an accurate discrimination of the pathological conditions, and an intimate knowledge of the virtues of each remedial agent (§ 686, *d*). Hence, also, the voluminous reports of cases, with or without the "numerical method," are only useful for the institution of principles in medicine (§ 672, 867). It is so with every thing, with food itself in every case of disease. The principle extends even to light in the treatment of ophthalmia; which also supplies another proof of the coincidence in the philosophy that relates to the operation of light and other vital agents (§ 74, 188½ *d*). And so with the agreeable emotions of the mind (§ 500, 539 *c*, 855).

If the reader will now attend, in connection with the foregoing principle, to what has been said of the nervous power (§ 222, &c.), of the laws of sympathy (§ 500, 512, &c.), and to other special circumstances which favor the operation of remedies (§ 143 *c*, &c., &c.), he will readily perceive the extent of his power in the judicious combination of a few only of the best remedies. But, to accomplish this art of combining remedies, in connection with the requirements in the preceding section (§ 871), demands an acquaintance with the whole ground which forms the basis of therapeutics.

872, *b*. And yet I would not abandon any part of the materia medica. I would hold it all, and all in connection; that what is good may be compared with what is indifferent or bad, and our knowledge of remedial virtues and remedial action be thus extended. There is also scarcely a recognized means of cure but is hallowed by the service it has done, and which it may do again, in enlightened hands, where the better means are wanting. It was with such intentions, and to promote the habit of a critical investigation of each member of the materia medica, that I was prompted to an attempt of arranging the whole according to their physiological aspects and therapeutical capabilities.

873, *a*. It is an important circumstance to be recollected, that many remedies are cumulative in their effects when employed in small doses; while the effects of others, on the contrary, lessen by use (§ 549–559). The action of the former, therefore, should be carefully observed during their progressive administration, that they may be promptly diminished or discontinued. The latter are not obnoxious to the equal objection of becoming morbific, as they must be often increased to obtain progressively their original effects; but much may be lost by neglecting the ascendency of habit in its aspect of diminished susceptibility (§ 535, &c., 841, 889 *b*).

These two important groups, however, are liable to some essential modifications. Mercurials, for example, in their constitutional alterative sense, are cumulative in respect to most adults, but very little so in regard to children, who are generally insusceptible of salivation

Again, in respect to agents which become inoperative from habit, this is often true of them only in certain small doses, and when frequently repeated. Tartarized antimony, in its minimum doses, generally diminishes the irritability of the stomach. But, if carried to the point of nausea, its effects will then be often cumulative, and the dose must be diminished, or incessant and aggravated vomiting may follow (§ 556, 841). Opium, hyoscyamus, &c., lose their effects, more or less, from habit, when continued at certain intervals, as twelve hours, and the dose, if expedient, may be increased; but if repeated as frequently, perhaps, as once in six hours, or less, they are cumulative, and the dose must often be diminished. By-and-by, however, under this frequency of exhibition, irritability becomes obtuse in relation to the agent employed, the opposite influence of habit obtains, and the dose must be increased to procure the original effect.

Many agents continue to produce about the same effects in the same doses, administered at certain intervals, however long continued. Such is true of ipecacuanha, and those vegetable substances which are allied to it. So, generally, of iodine, and many of its combinations. Much, however, depends upon the intervals between the doses. Unlike tartarized antimony, which it resembles in so many respects, ipecacuanha is cumulative as the intervals shorten below four hours, when the dose is a grain. The ipecacuanha will then often produce nausea and vomiting, while the antimonial, though repeated at far shorter intervals, is apt to lose its effect unless progressively increased to an extent which would prove emetic at the first dose.

873, *b*. In larger doses, or in their greatest admissible extent, all the foregoing agents are apt to be cumulative. This is true of the frequent exhibition of cathartics and emetics, though more so of some than of others. The dose of aloes which purges from the beginning must be often greatly lessened at the subsequent doses; or what was originally only a mild effect may soon become a violent one. This is also remarkably true of castor oil. All the cathartics, also, when administered daily in small doses, commonly raise the irritability of the intestine, and operate with increasing energy, though in some of the cases a part of the result may be due to an increased production of bile (§ 556, *b*).

874. It is an important circumstance, philosophical and practical, that the operation of narcotics is remarkably influenced by pain, and by certain states of the great centre of sympathies, as in *delirium a potu*. It is fatally opposed to the physical hypotheses, and to therapeutical conclusions from experiments on animals or on man in a state of health.

It is also interesting to the medical philosopher that pain has no remarkable modifying influence upon any remedial agents excepting the narcotics; and of those, such only as have a special relation to sensibility (§ 194, &c., 891).

875. We have now seen, in a general manner, that the susceptibility of the vital properties to salutary impressions, and their inherent tendency to a state of restoration, when driven by disease from their natural standard, has given rise to two general modes of treatment, which are familiarly known as the *active* and the *watching* or *expectant* (§ 853).

876. The *active* method consists in the application of such remedies

as produce artificial impressions. It comprises all that is attempted by art, in a direct manner, to promote the natural curative process. By this method, therefore, we forcibly institute those new pathological conditions which are most conducive to the salutary efforts of Nature (§ 150, 854 *b*, 855, 856, 901, &c.).

877. The system of *watching*, or the *expectant* plan, leaves Nature mostly to herself; only keeping obstacles out of her way. In its greatest latitude its advantages are exemplified in the self-limited diseases; but there is a period in all dieases, terminating favorably, when art should surrender the case to Nature (§ 858, 861, 867, 868 *a*).

878. So many evils have resulted from abuses of the *active* method, that great numbers, not considering that Nature is embarrassed in these cases by ignorance or carelessness, and, withal, having erroneous views in physiology themselves, do little else than *watch*. This is remarkably true of the homœopath, whose lessons from Nature have taught physicians that all the virtue does not lie in the amount of doses, and that a foe has arisen who can be exterminated only by consulting the philosophy of disease, and the *modus operandi* of remedies.

Nevertheless, although medical philosophy and a knowledge of the mode in which remedies operate be indispensable to the right treatment of disease, the community look only at the results; and while the homœopath cultivates his mind, there will be no inquiries, no interest, as to his theories. In America these innovations cannot prevail extensively, since the contrast will be vastly on the side of our Hippocratic practice (§ 709). But, in every section of the country there are some who are prone to a large and indiscriminate medication; and while this evil exists, homœopathy, in its original *practical* sense, will make its more successful demonstrations. Nor can it be doubtful that the tonic and stimulant practice which has risen in a sister state, and which still sways the British profession (§ 621, *a*), would yield a harvest to those who suffer Nature to take an unmolested, however unaided way.*

It is due, however, to truth (*fiat justitia ruat cœlum*), that the physiologist concede to the homœopath that his hypothetical views may be directed by an enlightened understanding of the properties and laws of healthy beings. Upon that ground, indeed, his hopes can alone repose; and even his doctrines in pathology and therapeutics are a thousand-fold better, more rational, more consistent, more conducive to health and to life, than any or all the tenets of the chemical and physical schools. With the one there may be a great deal of misapplied philosophy; with the other there is certainly none at all (§ 892, *i*).

879. It appears, therefore, that the active and expectant modes of treatment should be more or less associated; either taking the lead according to the general character of the disease, and the particular circumstances of individual cases. Having made the requisite impression by the *active* method, we should *watch* till another remedial change may be advantageously produced. When all is steadily in the right way, we should do nothing but watch. Another impression by an active agent would disturb the restorative process, and might so derange the vital states as to establish a condition of disease which art and nature together might not be able to surmount (§ 137 *d*, 150, 151, 854).

* See Dr. FORBES's "Young Physic.;" also, Prof. LAWSON's, and MEDICO-CHIRURGICAL's *Reviews* of the same, 1846.

880. Having, I say, placed the morbid conditions in the right way for the salutary efforts of Nature, but little else remains than to withdraw, in good time, the active interference of art. Much, however, as I have said, may remain to be accomplished by what may be called restorative means; such as a well-regulated diet, exercise, exposure to the air, &c. (§ 855). In protracted diseases Nature may also require the aid of tonics and stimulants; and this is mainly the advantage which they bestow. They are rather, therefore, adjuncts to medicines that are curative, than positively curative themselves. The same is also true of those narcotics which address themselves to exalted sensibility or irritability.

881. Though by the system of watching we intrust Nature with the cure, the active interference of art may be demanded by supervening obstacles. Such is the case, as we have seen, when visceral inflammations spring up in the self-limited diseases (§ 858). In these affections, also, in their simple states, general arterial excitement may become so excessive as to require the loss of blood, or alterative doses of tartarized antimony, &c. The remedies are designed for these specific objects, and not with any expectation of arresting diseases which have a strictly natural course and termination. The same principle is applicable to all other forms of disease; according to the nature of the contingencies that may arise after the restorative process shall have been introduced.

882. It is no uncommon prejudice that certain local, and even constitutional forms of disease should be allowed to continue for the prevention of some apprehended greater evil. This practice is founded upon the humoral hypothesis, and is one of the strong exemplifications of the fallacy of that doctrine. The intermittent fever is thus allowed to persist, that some peccant matter may be concocted and expelled; ulcers are cherished as outlets to vicious humors, &c. But, we are never benefited by the continuance of natural diseases. The sooner we get rid of them, the more shall we insure the chances of prolonged life, enjoy an exemption from corporeal and moral suffering, and manifest our common sense.

883, *a*. In considering what is to be done in the treatment of disease, we speak of the *Indications*. These consist of the suggestions that may be afforded by all that relates to the state of the patient. They refer to the symptoms, the seat of the disease, its remote and pathological causes, its duration, the habits, occupation, temperament, constitution, age, and sex (§ 686, *b*).

883, *b*. And here we may go back to the origin of our Science for one of those summary statements which can only flow from an enlightened and comprehensive view of organic philosophy, and which no subsequent observation has improved.

"Consider well," says Hippocrates, "the nature of causes, the nature and seat of the disease, what is most suitable to-day, and what to-morrow, what the vigor and what the mildness of treatment. A neglect of either may be fatal to the sick. Reason as a practitioner, and practice with reason." "Again, an important thing to be done is to consider the seasons of the year, the various changes, and the differences of their effects. Next, the winds, particularly such as are common to all nations, and such as are peculiar to certain countries." "The knowledge of disease is to be obtained from the common na-

ture of all things, and from the nature of every individual; from the disease, the patient, the things that are administered, and the person that administers them, for the case becomes easier or more difficult accordingly. We are, also, to consider the whole season in general, and the particular state of the weather, and of every country; the customs, the diet, the employment, the age, of every one, the conversations, the manners, the taciturnity, the imaginings, the sleep, the watchings, and the dreams; and how far vellications, itchings, and tears, are concerned; and what the paroxysms are; what the evacuations by stool, or spitting, or vomiting may be; and what changes may happen from one disease to another, and their various consequences. Sweat, cold, shivering, cough, sneezings, sighing, breathing, belchings, flatus (secret and audible), hemorrhages, and hemorrhoids, are also to be considered, together with the consequences of each" (§ $5\frac{1}{2}$ *a*, $350\frac{2}{3}$, 821 *c*–823).

884. When the foregoing indications are subjects of attention, we pursue the *rational* system, which is so called in contradistinction to the *empyrical.*

The *rational* treatment looks, also, at the physiological states of the system, and considers disease in its relations to those states. It is constantly concerned about the laws of vital actions, and regards disease as consisting in their modifications. In short, it proceeds upon the broad ground of inductive philosophy, and, therefore, takes in its scope all the principles of medicine (§ 639, *a*).

The *empyrical* practice, on the contrary, discards every thing but a few prominent symptoms, and would as soon relieve the pain of pleurisy by opium as that which attends a spasm of the stomach. Such, rather, is the common acceptation of *empyricism.* But, it is more a prevailing usage with the ignorant, and with those who discard the rational treatment, to be regardless even of abstract symptoms, and to be mostly swayed by the humoral hypotheses (§ 4 *b*, 744, 821, 824, 830, 835).

885. Symptoms, however, are the most essential, in their relative bearing, in the series of indications. They inform us of the organs affected, conduct us to a knowledge of the pathological cause, and frequently contribute their aid in detecting the nature of the remote causes, by which the pathological is determined (§ 644, 667, 678).

A few diseases have a particular symptom which is pathognomonic; as the eruption in small-pox, measles, &c. But signs of this nature are very rare, and still rarer the strictly vital phenomena (§ 682, *b*).

In the great class of inflammations, there are certain symptoms common to the whole, which, being more or less present, denote the presence of this disease, and thus become a general guide to the treatment, through the light which they shed upon the general pathology. That treatment is the antiphlogistic; but whether it shall consist of bloodletting, cathartics, alteratives, blisters, &c., individually or collectively, and to what extent, will depend not only upon the amount and severity of the general symptoms, but often, also, upon many others less uniform that may relate to each individual case, and which frequently mark some special modification of the common form of inflammation (§ 721, 722).

886. Next in importance to the immediate symptoms, and as often indispensable to a correct apprehension of the pathological cause, is

a knowledge of the *predisposing causes.* This, also, has been amply shown in its appropriate places (§ 644, 742, 776, 813, &c.). To these causes, besides the more immediate, belong the innate tendencies to particular forms of disease, and, more or less, all the natural and acquired temperaments, and all the habitual deviations from the natural standard of a sound constitution (§ 143–147, 561, 661, &c.). It is evident, therefore, where there are many remote causes concerned in the production of any given case of disease, that a few only, perhaps but one, have an important agency. Those few, or this one, are most important to be known ; and so of the others in proportion to their modifying influence. In the great families of fever and inflammation, there is generally but one principal cause for each modification, which is generally transient, or may appertain to the constitution. In the latter case, as where phthisis pulmonalis arises from the combined influences of cold, moisture, errors in food, &c., I regard these apparently predisposing causes as simply exciting, and assume the natural predisposition as the predisposing cause (§ 661).

887. The great value, then, of a knowledge of symptoms and of the remote causes of disease is that of conducting us to a right understanding of the pathological cause. In forming our indications of treatment from the symptoms alone, we may effect the removal of many, but in so doing we may aggravate the disease, and perhaps destroy the patient. This is conspicuously seen in the bark and wine treatment of those congestive fevers which destroy so many of the human family; one symptom only being the guide of practice in such cases. "Debility," indeed, is practically rendered the disease itself by philosophers of the tonic and stimulant school (§ 476 *c*, 487 *a*, 488½, 569, 621 *a*).

888, *a.* It is commonly a simple problem for the enlightened and observing practitioner to resolve the *general* character of any pathological condition. With this knowledge we are ready to act in a certain general manner, or, as it is called, upon general principles. But, there is something far more difficult, though often scarcely less important to be known, in many cases of disease; namely, the particular species, or rather variety, of inflammation, of fever, &c., which any given case may present. Having found this last important point in the cases supposed, and settled the modifying influences of contingent causes, we are fully prepared for all the details of treatment.

888, *b.* Owing to variations in the pathological state of many cases of a common form of disease, but where no fundamental change in the general character of the affection has happened, it may be necessary to employ remedies in apparent opposition to each other. But, in these cases, there is no violation of principle, no inconsistency of Nature. A different conclusion only proves that we do not interpret Nature correctly. To reconcile the seeming inconsistency, it is only necessary to recollect the explanation which I have given, that our remedies cure by instituting new pathological states, and that a certain variation of disease from that condition to which loss of blood is generally most appropriate may render stimulants, along with antiphlogistics, the best means for instituting the pathological change that shall be most conducive to the restorative process (§ 752–756, 870–872).

888, *c.* There are a few fundamental points to be carefully consid-

ered in all cases in relation to the effects of remedies. They refer to the principles and details already propounded.

1. The direct local effect of remedies upon the part to which they may be applied.

2. Their sympathetic effects upon remote parts.

3. Their ultimate effects after their direct action is over.

4. The general influence each remedy may exert upon the course and termination of disease.

888, *d*. It is one of the most remarkable facts connected with constitutional principles, that those organs which are most important to life are either within the direct reach of medicine, or they sympathize with such more powerfully and more readily than do the less important (§ 129, &c.)

It is also to be observed that the parts through which we operate artificially, and with which those vast and important sympathetic relations subsist, are of an external nature, and admit the application of powerful remedies to their surfaces.

And yet, again, observe that whenever no useful results would follow the direct application of remedies to other organs, such organs will not admit their application without injury to themselves and to others remotely situated. Nature has therefore kindly given to us two surfaces through which we may act upon all diseases; while she has placed a barrier against the entrance of all morbific agents into those parts where the direct action of remedies would be useless or detrimental.

888, *e*. I now leave the subject of therapeutics in its general aspects, to illustrate the doctrines which I have propounded, and to advance the rational treatment of disease, by investigating still farther the modus operandi of remedial agents, and as that philosophy is modified in its connection with the operation of loss of blood. At a future time it will be my purpose to carry the same philosophy through all the details of the Materia Medica.

Before proceeding, however, to the summary consideration of the modus operandi of remedies, I shall make a more practical analysis of the therapeutical effects of certain agents which are capable of a wide range of influences, but between which the resemblances are so obscure as to have contributed not a little to the errors which prevail in respect to the impressions they produce, or discourage others from all expectation of ever attaining any knowledge of their operation beyond their direct manifestations. I shall select such agents for this purpose as will be most conducive to a ready apprehension of the modus operandi of all others, especially the most important and most neglected of all—neglected practically as well as philosophically—loss of blood. Those agents may consist of *cathartics*, *astringents*, *tonics*, *narcotics*, *antispasmodics*, *arsenic*, *Peruvian bark*, or, rather, the alkaloid *quinia*, *iodine*, and *ergot*. The last four will illustrate what is known as *specific* action. In the Peruvian bark I shall also bring into view an agent possessing two prominent and rather opposite virtues, and thus attempt the just application of a compound agent to important problems in disease. So, also, with rhubarb, &c., when speaking of astringents.

While considering the therapeutical uses of the foregoing agents, I shall also indicate their morbific capabilities; and, as an important means of engaging attention, I shall dwell upon their abuses.

The advantages of irritants, applied externally, especially vesicants, will follow in the train; and bloodletting, the first in importance, will be reserved for the last, that it may have the united testimony in its behalf of all that precedes.

I am also prompted to these inquiries by a desire to introduce the treatment of inflammation, fever, and venous congestion, along with my investigation of their pathology, &c.

CATHARTICS.

889, *a*. What I may now say of cathartics is a continuation of what has been set forth in section 863, *d*. Their definition as founded upon their most sensible and uniform effect is—agents which increase intestinal evacuations. But this acceptation scarcely refers to any of their important physiological and therapeutical influences; which are just as intelligible, through the various resulting phenomena, and the laws of which I have hitherto spoken, as the evacuations they produce.

The increase of peristaltic motion, and the augmented product of the intestinal mucous tissue, spring from the irritation which is exerted upon that tissue by the action of cathartics; and the whole group of these agents are more or less capable of producing those results. It is through this irritation, which is variable in its *kind* according to the nature of the cathartic, that all the remote influences which they exert arise; and as these remote effects depend upon modifications of the nervous power corresponding with the nature of the primary impression, it is obvious that one cathartic may be speedily curative, while others may be profoundly morbific, in certain given conditions of disease (§ 52, 150, 227, 228, 500).

But cathartics exert, also, important effects upon remote organs by continuous sympathy; as upon the stomach, and especially upon the liver (§ 498). It is extremely common, for instance, when a cathartic is about operating, for nausea or vomiting to take place; which, however, may result from remote as well as from continuous sympathy. And here I bring the analogous influences of leeching into connection with the illustration to which I formerly adverted (§ 498, *f*, *g*). By the foregoing manifest irritation of the stomach we see, also, how the vital condition of that organ may be at the same time profoundly affected, either for better or for worse, by the mere action of cathartics upon the intestine. And that this is truly so, is evident from the manner in which we often see gastric disease subside, or produced, or increased, immediately after the nauseating effect of a cathartic. But, should the same results happen without nausea, we know from the connection of phenomena now stated, that they have resulted in the more obscure instance from exactly the same influence, though the prominent symptom of nausea happen to be absent. We thus arrive at the farther knowledge that cathartics not only throw their powerful influence, by remote sympathy, upon distant organs, in virtue of their intestinal action, and in the same manner as the stomach is affected by the remote process, but how, also, this organ is simultaneously rendered the point of departure of other profound influences upon distant organs.

If we now look at what is going forward in the liver, at the same time, we shall see that here, also, are phenomena which denote the same principles, and the same chain of causation. Take, in the first

place, what is most obvious to the senses, the bile; and we find it often greatly increased during the operation of cathartics. Now it would be clearly wrong to explain this phenomenon upon any other principle than that which I have assigned for the nausea and vomiting; that is to say, by remote and continuous sympathy. This may remove the embarrassment which the liver has offered to the mechanical philosophers as expressed in section 829. Here, also, as in the case of the stomach, we find that disease simultaneously subsides, or is produced, in the liver, and we know that it depends upon the same causes that had given rise to the production of bile. But this is not all. The liver, from its important connections with other parts, now radiates, as in the case of the stomach, other important influences upon distant parts, while, moreover, it may yield important relief to the brain, or the stomach, or intestine, &c., through an increased secretion of bile (§ 863).

From the foregoing phenomena relative to the effects of cathartics upon the stomach and liver, we reason in the same way to the various results which those agents exert upon other organs; and this reasoning is corroborated by all that is known of the laws of organic beings, whether in health or disease, as well as by the consistency of nature, and unity of design.

889, *b*. But, cathartics often produce their full curative effects upon remote organs without determining any alvine evacuation; and this proves to us that the great curative operation of cathartics is of a physiological nature. Nothing, indeed, is more common than to exhibit cathartics when the intestine is empty; and all the good we then obtain from them (and it is often great) arises from those vital influences of which I have been speaking. If much bile, mucus, &c., happen to be discharged in these cases, they are mainly generated during the action of the cathartic (§ 694½). In almost every acute disease of much importance, cathartics are administered, and if not with the intention of which I am speaking, they are employed empyrically. When no such specific object is contemplated, they are given merely because it is customary to do so; always excepting the humoral interpretation (§ 819, &c.).

889, *c*. In my *Arrangement of the Materia Medica*, I have placed the chloride of mercury and blue pill as the first in importance among cathartics; and yet their purgative effect is comparatively very little with many of those which I have arranged as the most inferior. This was plainly done for the reason that the curative influences of these mercurial preparations are far greater, in a general sense, than those of any other cathartic. Experience assures us that the arrangement is right; while philosophy, as also founded on observation, enforces the truth that the most drastic cathartics inflict their injuries through exactly the same principles that the less purgative exert their good effects.

We thus see how liable definitions are to lead us astray; and this is true of most of the designations which I have retained in my Physiological Arrangement, and more particularly so of those general denominations, such as demulcents, revulsives, deobstruents, &c., which I have excluded (§ 729 *b*, 819 *a*).

889, *d*. We may make up our minds, therefore, that the mere purgative effect, or the evacuation of the fecal matter, abstractedly con-

sidered, is one of the least that is exerted by cathartics; and nothing can be said in behalf of their supposed action upon the blood.

889, *e*. Nevertheless, it should be steadily considered, that fecal accumulations are a source of mechanical irritation, at least; or, if they consist more or less of fermented food, they also irritate in virtue of their specific properties, and, in both the cases, exasperate remote diseases through the same physiological laws that are relative to the good or bad effects of cathartics. It is then an object to remove these exciting causes. But, if none of the important vital influences of cathartics be then contemplated, we should employ such only as are mild, and whose action does not extend much beyond the intestinal canal. Precisely the same rule should also obtain in the administration of emetics. Tartarized antimony and ipecacuanha are all we want for profound curative virtues; and sulphate of zinc for superficial action, or, at most, associated with one of the others where gastric irritability is rendered obtuse by narcotic poisons.

889, *f*. Does the reader now inquire, why it so frequently happens that the best effects of cathartics, in diseases remote from the intestines, are obtained only when they operate decisively, and perhaps powerfully? The answer is important; for it goes far to illustrate the modus operandi not only of cathartics, but of all remedial agents. It is, then, because this strong impression upon the vital condition of the intestinal mucous tissue is necessary to establish those sympathetic influences in remote parts that may be the seat of disease, which result in such a change as brings about their own natural curative tendency. The repeated evacuations are a necessary consequence of that requisite impression upon the intestinal mucous tissue, and serve as an evidence that such necessary impression has been produced.

889, *g*. It appears, therefore, that the results which follow the action of cathartics may affect powerfully all organs, however remote they may be from the intestine, without resorting to the common assumption of absorption, or to any doctrine in the humoral pathology. In all this, too, we are aided not only by our knowledge of the physiological relations of the intestinal mucous tissue to all other parts through the sympathetic nerve, but by its anatomical connections with the liver and skin, and by its vast extent. It is also the seat of some of the most important vital functions, and it is here that the whole lacteal system takes its rise, and here is the great concentration of the sympathetic nerve in the semi-lunar ganglion and solar plexus, with the contributions from the pneumogastric nerve and spinal cord.

It is owing to these vast and important anatomical and physiological connections, that, when disease springs up in the intestinal mucous membrane, it sheds its morbific influence abroad over the whole system; now developing, sympathetically, cerebral inflammation or congestion; now of the liver; again, inflammation of the skin; at another time, of the bladder; in this subject rheumatism; in that, scrofula; in another, croup; in others, inflammation of the fauces; here, of the eyes; there, of the nose; here, an attack of the gout; there, abortion; and so on, through every part of the organization.

Considering, therefore, I say, the foregoing anatomical and physiological relations between the mucous tissue of the alimentary canal, and how diseases of this membrane may give rise to disease in every other part, we may readily comprehend how it is that cathartics exert

powerful sympathetic effects upon distant organs when rendered unusually susceptible by disease. And so of all other remedial agents, internally applied, according to the nature of their virtues, their doses, &c.

889, *h.* From all which it follows, that three principal advantages are contemplated from the operation of cathartics; namely,

1st. Their sympathetic influences, remote and continuous.

2d. The increased secretions to which they give rise; especially from the intestinal mucous tissue, and from the liver.

3d. The evacuation of the fecal matter, which, in a general sense, is the least of all.

889, *i.* Certain cathartics affect certain portions of the intestinal mucous tissue more than other portions; and this is owing to the peculiar modifications of the organic properties in different parts of that tissue, and the peculiar vital relations of particular cathartics to one or another of those different parts (§ 134–137, 150.) These special relationships should become the subjects of critical investigation, since it often happens that cathartics may be advantageously selected with a view to these exact physiological conditions. The fact is more or less understood, but not so the philosophy. There are some great errors, however, as to the facts. Aloes, for example, is supposed, universally, to exert its effect especially upon the large intestine, while, in truth, its influence is vastly more upon the jejunum and ilium, as abundantly manifested in irritable states of the small intestine, and by the manner in which it aggravates the general arterial excitement of fever and inflammation. The irritation of the highly-sensitive anus which has given rise to the prejudice depends mostly upon the sudden production of morbid bile which aloes elicits by its special influence upon the liver; and this, also, is a proof of its direct and main effect upon the superior portion of the alimentary canal (§ 718). But again, we have an opposite demonstration of the same philosophy, in the failure of aloes to be attended by this irritation of the anus in the absence of hepatic derangements; and then, also, there is comparatively little bile evacuated.

The great governing principle, however, in the selection of cathartics, should be their known effect upon disease, according to its seat and pathology. If applied with a view to their special action upon one part or another of the intestinal canal, they will be often liable to the worst practical consequences unless the philosophy which I have set forth upon this subject be considered accurately along with experimental observation of the relative virtues of the different cathartics; and, I may add, that the more these relations are studied, the more apparent will that philosophy become in its truth and importance (§ 52, 134–137, 150).

889, *k.* From what has been hitherto said of the philosophy of life, and as modified by disease, we readily understand how cathartics may be greatly varied in their action by associating two or more together, or by uniting with them agents from other groups. Each combination is a new remedy, and a new one, too, according to the exact proportions of each ingredient. How important, therefore, a critical regard to all the details involved in these suggestions! But, there is no problem, I say again, more difficult in practical medicine; and next to that is the right dose of the whole, or of any single agent, and

next in order the time for its repetition, or for the substitution of some other remedy.

The combinations of which I speak act as a whole upon the properties of life; just as the various rays of the sun in producing the sensation of white light (§ 188½, *d*). But, like the rays of the solar beam in their action upon life, there is nothing in inorganic nature which offers a similitude; while, also, it is worth saying, in farther illustration of the whole subject, that the rays of the solar beam never act collectively on inorganic matter.

If we now take an example, familiar as it may be in practice, it may help our philosophy as to all other combinations of remedies, and guide the practical hand in regulating the proportion of ingredients, the doses, &c. Thus, cathartics may become completely inoperative, as such, by the addition of opium. This is done by rendering the irritability of the intestinal mucous tissue so obtuse that it cannot be roused by the irritating virtue of the cathartic. Diminish the proportion of opium, and the cathartic irritates moderately and purges slightly. Reduce the narcotic still more, and the cathartic irritates more and purges more. Omit the opium, and the purgative effect may be violent and attended by great pain. And, in doing all this, we also variously modify the remote sympathetic influences of all the agents which are thus employed (§ 227, 228, 500, &c.).

This is an example for all other combinations of remedies; for the same philosophy is concerned throughout. We see, too, in this example, how the combination acts as a whole. The cathartic and narcotic simultaneously impress irritability and sensibility; each exerting its force upon those properties of life in the ratio of their proportions, and according, also, to the existing state of the properties (§ 137 *d*, 150, 189, 191, 872 *a*).

889, *l*. Cathartics are often cumulative in their effects; but this will depend much, as with numerous other remedies to which this principle applies, upon the frequency with which they are administered (§ 556–558). If the interval be short, as about four or six hours, and the same dose be continued, the last may operate with violence, although the preceding had manifested no effect. But this is far from being always true. Indeed, it is often necessary to increase the dose, even when exhibited at these short intervals; and we arrive at a knowledge of all this, and sufficient for the exigencies of the case, whether as to dose, the nature of the cathartic, or time for repetition, by considering the existing condition of the intestinal canal, or other contingent influences, such as jaundice, &c. But here, embarrassments frequently grow out of constitutional peculiarities of patients. These natural peculiarities, in relation to cathartics especially, are often remarkably great; one patient bearing far larger doses, and more active cathartics, than another under apparently the same circumstances of disease; just as in the case of bloodletting (§ 912). I am therefore always in the habit of interrogating patients with whose susceptibilities in this respect I am unacquainted, as to the quantity of salts, or of castor oil, they may be in the habit of using, with a view to their action upon the bowels. This enlightens us greatly as to their probable susceptibility to the action of other cathartics; and, with the object of extending the philosophy which concerns this subject, I will add that this knowledge as to cathartics will not help us with any other agent. Every other must be subjected to the same analysis.

There is another and important modification of the cumulative effect of cathartics, according to the frequency of their repetition, and which may be said to apply, more or less, to most other remedies whose effects are cumulative (§ 155–158). We have just seen, that if cathartics be administered once in four or six hours, that effect is variously manifested. But, if the interval be much shorter, the cumulative influence will be more strongly pronounced. This is owing to the persistence of the modified state of intestinal irritability after each successive dose. Each dose, if soon repeated, raises irritability more and more, so that each, in succession, operates more and more. But, if the intervals be long, irritability returns to its natural state, and a larger dose will be necessary to make an impression (§ 137 *d*, 415 *g*, 516 *d*, no. 6, 549–558, 857). The principle now concerned explains the reason why tartarized antimony or ipecacuanha when united with the sulphate of zinc will take effect as soon as the latter. It is the same, too, which brings the permanent tonics into speedy operation when associated with the analogous diffusible stimulants (§ 890½, *g*).

Now, therefore, if the interval be quite short between the doses of a cathartic, their cumulative effect will be more and more strongly pronounced. Thus: if an infusion of senna, or a solution of salts, forming, respectively, one full dose, be taken in divided quantities every half hour, the entire quantity of either will often purge more actively than if the whole of either were taken at once. So, if a grain of ipecacuanha be administered once in four hours, it will generally fail of producing nausea; but if half a grain be exhibited once in two hours, it will be more apt to nauseate. There are peculiarities about tartarized antimony and other agents, in this respect, which have been considered under the designation of vital habit (§ 535, &c., 873).

A common principle applies to all the foregoing cases, is extensively ingrafted upon morbific and remedial agents, and of vast importance to the hand of art. In the cases recited, by the frequent repetition of the remedies we increase progressively the susceptibility of one part or another to their peculiar influences, either directly or by remote sympathy. We bring the virtues of the different agents more and more into relation with the organic properties; and, when that relation is fully established, the last dose appears to exert, and may exert, a greater power than all that had preceded it.

889, *m*. We may now, perhaps, more readily comprehend a part of the philosophy which should govern us where it is mainly an object to remove habitual constipation, and to which a brief reference was made in a former section (§ 556, *b*). In cases of this nature, there are two primary objects to be kept in view: 1st. To avail ourselves of the cumulative effect of cathartic remedies; 2d. To establish a free secretion of bile, which is commonly deficient in these cases. To obtain these objects, it is obvious that the cathartic should be administered with a certain frequency, and that it should be of a certain kind. The cathartic should be of the best alterative nature, that it may reach the liver, and establish the most favorable change in the intestinal canal; the last of which has been already stated (§ 556, *b*). Castor oil is also valuable for this purpose (PAINE's *Materia Medica*, p. 34). It is plain, also, that the doses should be so small as not to produce irritation; for this would soon result in positive disease. The most violent agent may be rendered mild by a proper regulation of the dose.

It is therefore less the energy of the remedy, than its salutary alterative virtues, that is to be considered. In pursuing the treatment, our object should be to imitate Nature as nearly as possible: that is to say, to produce one free movement, daily, in the adult, and one or two in infants. The remedy, therefore, should be administered at least once in a day; or, if it can be rightly adjusted, evening and morning would be still better, at the beginning of the treatment. By this process we gradually alter the irritability of the intestine and bring it fully into relation with the virtues of the agent; and, as the bile possesses, alone, cathartic endowments, we shall have thus adapted intestinal irritability to the action of that natural and now augmented stimulus. The case is parallel, in its philosophy, with that of the emetics and tonics, as stated in the preceding section (889, *l*).

It hence becomes manifest, that, by pursuing this course, we shall soon be under the necessity of diminishing the dose with which the treatment was commenced; till, at last, the quantity dwindles away to such minute doses, that the stimulus of the bile and the mechanical irritation of the alimentary matter supersede the farther use of the medicine; or, the minute doses may now become morbific.

It not unfrequently happens, that, at the beginning of the foregoing treatment, the doses fail of their intended effect; when some other cathartic, as a little castor oil, or Rochelle salt, should be exhibited, but not enough to operate actively. Their active effect would interfere with the process of bringing the organic properties into a fixed relation with the small doses of the more alterative remedy, and subsequently to their natural stimulus, the bile.

In all this series of influences, it is clear enough that a change is established in the condition of the liver; but a not less important one occurs in the vital state of the intestine.

889, *mm.* If we now regard, for a moment, the universal system which is pursued of administering active doses of cathartics, in the foregoing cases (§ 889, *m*), at intervals of two, three, or more days, we shall readily see that different results must follow; while experience teaches that constipation is not often surmounted in this manner. Too much violence is thus inflicted, nature is embarrassed, and is incapable of instituting those salutary changes which we have seen to arise in the former case.

Nor is it alone the intestine which fails of being diverted from its torpid state. A shock is propagated to the stomach; the liver violently impressed, and natural changes are not instituted in its action, and a continuous flow of increased bile is not established (§ 889, *a*).

It is readily seen that rhubarb, for the sake of its tonic virtue, may be often substituted for the aloetic and mercurial compound (§ 556, *b*), or associated with them, or ipecacuanha sometimes intermingled. Or, at other times, it may be greatly best to substitute mild enemas, whose action is explained in section 498, or again to depend upon diet, exercise, running especially, &c. But, a very common error is committed in these cases, as it respects food. It is not considered that the stomach often suffers as well as the intestine; and all the laxative food, as it is called, which is employed with a view of increasing the residuary matter, is apt to inflict a greater injury upon the stomach than any advantage that may arise from its mechanical irritation of the intestine. These are cases, therefore, for a very limited diet of those

things which are easy of digestion, and for the alterative treatment by medicine, exercise, &c.

889, *n*. And now as to the time, in a general sense, most appropriate for the exhibition of cathartics, and the philosophy which concerns it (§ 863, *d*). There is a certain attendant of the human constitution, as already seen (§ 768), which disposes the system to daily periodical excitement. This natural phenomenon takes place late in the afternoon, in all parts of the globe. I have considered its application in a pathological sense, and it is of great importance in that double acceptation as it regards the operation of cathartics.

It is obvious, I say, that the system is in its most irritable and susceptible state toward the decline of the day, and that this period must be the worst for the operation of so powerful an irritant as cathartics, and more especially so if fever or inflammation be present (§ 137, *d*); though there is a great difference, in this respect, among different cathartics. The most appropriate time for their administration, in a general sense, is toward the decline of the natural evening paroxysm, or between ten o'clock at night, and eight o'clock in the morning. This will also generally bring their exhibition in febrile affections at an early stage of the remission of fever, so that their operation may be over before the access of another paroxysm. The same principle applies to inflammation; for, although there be no manifest exacerbation in the afternoon, the disease is under the natural tendency of the system to a sate of excitement at this period of the day.

At a late hour in the evening, the natural paroxysm is fast on the decline, and this is the most suitable hour for those cathartics whose operation is slow; as calomel, blue pill, aloes, &c.; and if other purgatives be afterward necessary, they may follow in the morning with a speedy effect. In this manner, the repose of the patient is not disturbed, and is conducive to the salutary influence of the highly-alterative cathartics. These cathartics exert powerful influences upon organs that may not be the seat of disease; which is particularly true of the skin. Now this action which is thus instituted in the surface transmits a curative sympathetic influence to parts that are diseased, and both the impression upon the skin and its salutary sympathetic influences will be much promoted by the warmth of the bed, by the horizontal posture, and by sleep. For the same reason, if cold should arrest the action in the skin which the cathartic institutes, that organ, suffering this violence, may reflect morbific sympathies upon other parts, and may thus, more or less, defeat the useful effects of the cathartic (§ 514, *h*).

But, all cathartics whose operation is speedy should be exhibited at an early hour in the morning, when the irritability of the system is least, and sleep has had its balmy influences.

ASTRINGENTS.

890, *a*. Astringents are commonly supposed to act upon physical principles more than any other remedial agents, and that their special operation is analogous to the tanning process (§ 569, *b*). I shall endeavor, however, to show that Nature is so far consistent with herself, and that all the facts in the case enforce the conclusion, that astringents operate like all other remedial agents upon vital principles, whether they be administered internally, or applied to the external

surface; that they operate by so modifying the living properties and actions of the secerning vessels, that redundant secretions of blood, or of other fluids, are arrested in virtue of that change of vital action.

890, *b*. Let us now look for an illustration of the foregoing to some agent which embraces other virtues in connection with that which is reputedly astringent. There are many of these; such as the sulphate of zinc, the sulphate of copper, rhubarb, &c. We will take the last mentioned, for the sake of indicating, also, its uses in practice. This substance is positively cathartic in certain therapeutical doses, but so stimulating to the system in such doses, as to render great caution necessary in its administration in acute inflammatory diseases; while, on the other hand, in much smaller doses it is adapted to many chronic inflammations. Again, in certain other small doses it is a valuable tonic, but still contra-indicated by active inflammation. Lastly, it is a powerful astringent in various doses, from its smallest alterative, to its full cathartic dose; operating under particular circumstances of disease as a direct astringent in its small doses, as in diarrhœa, yet, in an opposite state of the bowels, as in constipation, proving an admirable laxative in the same small and repeated doses (§ 889, *m*, *mm*); while its wonders cease not even in its full cathartic dose—for now in diarrhœa it first operates as a cathartic, and then shuts up the bowels as an astringent.

Now, to what causes are all these diversified and apparently contradictory effects owing? They depend upon the natural susceptibility of the organic properties to changes according to the virtues of the agents which may act upon them, and their existing state when the agents are brought into operation; and, secondly, as well, also, upon the doses in which they are administered. When the vital conditions are affected in a peculiar way, and under a given combination of circumstances, if a vital agent possessing particular virtues be applied, it will so modify or alter the existing morbid state, that new and definite results will follow. Thus, when the intestinal mucous tissue is affected with that condition of disease which results in a preternatural watery secretion, and consequent evacuations, which is called diarrhœa, and rhubarb is administered in a certain dose, this substance first impresses the membrane in such a way as to determine an increase of the peristaltic movement; but it simultaneously alters the morbid state of the intestinal mucous tissue in such a way that the unnatural secretion is arrested; while the change which is thus established in the mucous tissue is a removal of a morbid stimulus from the muscular tissue of the intestine, upon which the diarrhœal evacuation in part depended. The diarrhœa thus ceases after the rhubarb has acted moderately as a cathartic. The same causation which determined the action of the rhubarb as a cathartic changed the morbid state in such wise as to arrest the farther production of the intestinal fluid, and the preternatural determination of the nervous power upon the muscular coat of the bowels.

Whether, therefore, the rhubarb purge, or prove astringent, or tonic, a common principle and common laws are concerned throughout; and all the sensible results depend upon certain alterations which the agent effects in the vital properties and actions of the vessels, or tissues, which are the seat of the morbid conditions, or in which the various phenomena may take place.

Just so it is, also, with the sulphate of zinc, or of copper, or ipecacuanha, when they restrain hæmoptysis by their emetic effect, or when in smaller doses they arrest other hemorrhages, or diarrhœa, or at other times bring about the results of ordinary tonics. Consider, too, the special, but analogous, effects of opium; which, in arresting intestinal secretions, or those of the liver and kidneys, surpasses every astringent. And yet opium has no astringent principle, nor has it ever been supposed that this remedy checks those products by astringing the vessels or condensing the tissues. Nevertheless, it arrests them in nearly the same way as the pure astringents effect the removal of hemorrhage, diarrhœa, gleets, &c. And what lets us particularly into the philosophy of this subject is the coincidence in the effects of opium as it respects the simultaneous diminution of the various other products of the abdominal organs; the cause of the diminution of the bile, and of the urine, being the same as that of the diminution of the diarrhœal product of the intestine.

890, *b*. What I have now explained comprehends the whole philosophy of the operation of astringents. When they arrest the discharge of ulcers, or of blood from the stomach, or of any part with which they come in direct contact, it is mostly by their direct action upon the vital condition of the parts. In other cases it is through the medium of the nervous power. And here we may look at the coincidence in results between the application of an astringent to a suppurating surface and as the same discharge is arrested by a tonic, or by exercise, or change of air, &c. (§ 227, 228, 855). It is the change of action upon which the cessation of the various products depends, and this change may or may not be attended by a vital contraction of the secerning vessels, or of the vessels of any tissues upon which the agents may exert their direct effects.

Other remedies, such as loss of blood, and that one of a negative nature, cold, which often surpass the pure astringents in arresting effusions of blood, &c., may be brought to the same interpretation of the modus operandi of those astringents.

890, *c*. When astringents are applied to outward surfaces, as to leech-bites, wounds, &c., they are called *styptics;* and in relation to those agents which are designed for the purpose of arresting external hemorrhages only, there are many which act mostly upon mechanical principles; either by pressure upon the bleeding vessels, as with lint, agaric, cobweb, &c., or by coagulating the blood which exudes from the part; while they also stimulate the bleeding vessels to contract.

890, *d*. Astringents are another class of remedial agents which have been greatly abused, as well as applied with little reference to the pathological states they are designed to correct. Hemorrhage from every part, frequent discharges from the intestine, whether watery, bilious, or mucous, the discharge in gonorrhœa, leucorrhœa, &c., are treated by vast numbers according, alone, to the physical conceptions of the action of astringents; and those agents, therefore, are indiscriminately applied to all the foregoing conditions. Beyond this consideration, the discharge alone is an object of attention; the disease appearing to consist in this particular symptom. Many of the preternatural effusions depend upon inflammation or congestion, which astringents rarely fail to aggravate. And yet nothing is more common than the exhibition of those agents in these pathological conditions,

without any antecedent treatment by other remedies. It is a common practice, for example, to exhibit the acetate of lead, or some other pure astringent, for a moderate hæmoptysis. The effusion, being instituted by nature for the relief of the congestive state of the lungs in which it originates (805, 1019), and violently arrested by the astringent, is counteracted in its great final cause. But the astringent not only inflicts that evil, but is also apt to increase the pulmonary affection by its direct morbific action; just as they increase dysenteric inflammation when they establish the change by which the redundant secretion of mucus is arrested. A very frequent ultimate consequence of the former untoward treatment is tuberculous phthisis. This practice has received a great impulse in recent times from morbid anatomy, especially as promulgated by Louis and Andral, and carried forward by British pathologists; who deny the dependence of tubercle upon inflammation. Nor can we desire a better proof of the importance of rendering all such pursuits entirely subservient to the demonstrations of living Nature (§ 756. Also, *Med. and Physiolog. Comm.*, vol. ii., p. 608–634, 743, 744, 748, 780–782, 799).

Instead, therefore, of the foregoing mal-practice, along with the simultaneous use of a stimulating diet, these patients, if the hemorrhage be small, should be treated by bloodletting, or small doses of tartarized antimony or ipecacuanha, blisters, &c. These agents arrest the effusion, and so far they exert the effect of astringents. But they do more. They alter the morbid states in a mode which Nature was attempting; while the real astringents alter them for the worse; though a cessation of the hemorrhage may be equally the result of either method of treatment (§ 150, 151, 732 *b*, 733 *e*, 862–864).

There can be no sound practice till hemorrhagic effusions are recognized as the result of a secreting process, instituted by morbid states. The proof is abundant; but it is enough that we witness the consequent relief of disease, and apply ourselves to the analogy in this respect with what is known of redundant effusions of bile, of serum, &c., and which none can fail to recognize as salutary means employed by Nature. These hemorrhages, too, are analogous to menstruation, and here, as there, a great final cause lies at the foundation. There is, therefore, no more propriety in arresting hemorrhage, unless excessive, than in attempting to interfere with the natural function.

890, *e*. In the advanced stages of fever, and of other severe forms of disease, hemorrhages have been often followed by death. And here it is that hemorrhages have raised the greatest apprehension of their fatal tendency. But, it is very rare that it is the hemorrhage which destroys (§ 1019). It is only a symptom, at this advanced stage of the malady, significant of a fearful condition of disease, which, in itself, in a vast proportion of cases, is the true cause of death (§ 00, 863). The cause, therefore, is too apt to be mistaken, the blame too often attributed to a kind effort of Nature to throw off the deadly weight; and Nature would much oftener succeed by this depletory process were it not for the interference of art with its mischievous astringents. It is, however, always a fearful symptom in the advanced stages of acute disease. But, bad as it is, it should be hailed as the best possible event that can happen. The effusion comes directly from the congested parts, and if any thing can relieve them, it must be this spontaneous effort. Art cannot now interfere

with bloodletting. The golden opportunity may have been allowed to pass, either from ignorance, or fear, or from the difficulties of the case (§ 569, 960, 964 *c*). Nature, alone, can now institute the great remedy; and here it is that we so often witness the safety with which she makes her wonderful demonstrations of cure, and rebukes the timid practitioner. But she has now her own way of operating. She has taken the business of rational treatment upon herself, and out of the hand of art; for now it is that quarts of blood may flow away from the intestine, and triumph over disease, when bloodletting would be perfectly useless, and the abstraction of a dozen ounces of blood would probably be fatal. These are lessons from Nature of every-day occurrence, and should not be lost even to such as are incapable of appreciating disease, or who may be imbued with prejudice, or haunted by fear, in respect to the great remedy whose timely application would save them from the consternation of witnessing a natural outpouring of blood, and from the mortification of discovering that there may have been an important error in treatment.

These are cases which require, in all respects, a great precision of treatment. Where Nature may have laid the foundation of cure by hemorrhagic effusions, a slight error in practice may be fatal. And here, again, the fault is apt to be laid at the door of Nature, and thus the disposition to interfere with astringents is more and more increased. Nevertheless, we should watch these effusions with vigilance; and, whenever they appear to be transcending the exigencies of the case, or the ability of the system to bear them, we should endeavor to restrain them by appropriate astringents.

890, *ee.* Those philosophers who justly refer capillary hemorrhage to a secretory process have distinguished the condition into active and passive; of which hæmoptysis is an example of the former, and that which was considered in the last preceding section, of the latter. But, this distinction is as clearly unfounded as that of active and passive inflammation (§ 752, &c.). Here, as there, the varieties are nearly on a par in respect to the pathological cause. The differences which exist among them are owing to only slight modifications of that essential cause. The modifications, however, are such as may require variations of treatment; one of them the antiphlogistic, another the antiphlogistic and astringent combined, and another the astringent alone. They are thus seen to run into each other, and they offer problems where it is the nicest point to determine whether we shall bleed and purge, or administer an astringent.

890, *f.* When hemorrhage supervenes upon chronic forms of disease, it commonly happens that it must be great to overthrow the obstinacy of habit; and the triumph of Nature is often thus displayed in the hæmatamesis which is set up by aggravated indigestion.

The hemorrhage attendant on tuberculous phthisis is a relief to the sufferer; but not often more than temporary. Nor can we now hope to do much by co-operating with Nature, any farther than to moderate the activity of disease by a non-stimulant diet, and blisters to the chest, or by general or local abstractions of blood where the quantity expectorated may be small. Astringents are always pernicious in these cases, unless the hemorrhage be excessive; and even then we shall generally fail to arrest the effusion on account of its connection with a serious lesion of organization. These, therefore, are cases

which sometimes prove suddenly fatal by the quantity of blood effused, or by its choking up the air-cells.

890, *g*. Cases of the foregoing nature (§ 890, *f*) appear now and then as consequences of badly-treated pneumonias, especially the congestive variety, or what is called typhoid pneumonia. But, we rarely witness any thing more than an expectoration of bloody mucus in the common form of the disease, or even in the congestive, if the treatment have been of the proper antiphlogistic nature.

890, *h*. Again, nothing is more extensively employed in the treatment of dysentery than rhubarb, and nothing more injuriously (§ 150). Its administration proceeds upon the erroneous views of the modus operandi of astringents and the want of a proper reference to the pathology of the disease. As that pathology consists in active inflammation, it should be manifest that rhubarb is one of the worst agents that can be devised; since it possesses not only the virtue of a true astringent, but is stimulant to the whole circulation, irritant to the whole mucous tract of the intestine, now morbidly susceptible throughout its length from the severe and specific inflammation of its inferior portion (§ 137 *d*, 398), and if the agent arrest the discharge, it is commonly by increasing and otherwise unfavorably modifying the inflammatory condition.

As in the foregoing case of hæmoptysis, therefore, we should have recourse to direct antiphlogistic means; and the cathartics employed should be of the least irritating nature, and then, only in cautious doses. But, they should be also of an alterative nature, and such as will reach the liver as well as the intestine. In a general sense, castor oil is the best (Paine's *Materia Medica*, p. 34).

If we now consider that ipecacuanha is the best internal remedy for dysentery, and the best for hæmoptysis, and that common table-salt is one of the best for the latter affection, it will help us greatly to the knowledge we are seeking as to astringents, and lead to many practical advantages.

890, *i*. Rhubarb, opium, and other agents which arrest redundant secretions, are often highly useful in some forms of diarrhœa, and sometimes in chronic discharges of mucus; but these products depend upon various pathological states, and whether astringent remedies will be useful or injurious will depend upon the precise nature of the disease (§ 150, 670–674, 733 *f*). In the simplest forms of diarrhœa they are more or less useful; particularly rhubarb, and that agent, chalk, which possesses no astringent virtue, but brings about the prominent result of an astringent merely by neutralizing some irritating acid. But soda or potass would not answer, since these irritate by their own virtues, and still more so by forming a neutral salt within the alimentary canal. Saline cathartics are, therefore, also improper, and, moreover, scarcely extend their salutary permanent effects beyond the intestinal canal.

890, *k*. But, even in the simple forms of diarrhœa, there is variety as to the exact nature of the morbid condition, which demands, in different cases, a choice of astringent remedies (§ 150, 672–674, 733 *f*, 863 *d*). One variety will be greatly benefited by rhubarb and chalk, but aggravated by opium. To another opium is exactly suited, as in pulmonary phthisis; and in such rhubarb may be detrimental, and pure astringents useless. To another variety, as in some old chronic

cases, the acetate of lead may be best adapted; and to others the pure astringents, such as kino, catechu, geranium, &c., when all other means which I have indicated would be either useless or injurious.

890, *l*. The foregoing examples illustrate variously the general principles which are propounded in this work. But, the variety of illustration may be greatly extended in respect to the remedies now before us. It often happens, for example, that frequent watery discharges are owing either to inflammation of the intestinal mucous tissue, or to a state approaching inflammation; as in cholera infantum. Here, all astringents are inadmissible; and, if the case be cholera infantum, such is the peculiar nature of its predisposing causes (§ 650–653), that there is nothing comparable with the mild chloride of mercury in doses varying from the twentieth to the eighth of a grain, once in four to twelve hours; perhaps, also, with a little chalk and the camphorated tincture of opium along, to neutralize an acid and to allay intestinal irritability. But it is the mercurial agent which does the work, by breaking up the morbid condition. Calomel, therefore, in such cases, is just as much an astringent as alum, or the acetate of lead, or catechu, in other cases of a modified pathology (§ 150, 151, 863 *d*).

890, *m*. Gonorrhœa is another example, and another form of inflammatory disease, where great suffering, and prolonged sickness, are induced by the want of a proper knowledge of the operation of astringents, and a proper discrimination as to the particular state of the pathological condition when the remedies are applied (§ 672). The preternatural discharge is apt, indeed, to be regarded as the disease; or whether so or not, it is a common practice to resort, at once, to astringent remedies, internally and by injections. Such, however, is the force of inflammation, and morbid irritability so strongly pronounced, that a direct antiphlogistic treatment should be at least premised; when, also, it will be commonly found that it has superseded the necessity of astringents. And here, again, we may remark how the coincidence in effects between the internal use of copaiba, or cubebs, and injections of an astringent nature, denotes a common mode of action, and places the whole upon vital ground. The frequent salutary effect of the nitrate of silver when employed as an injection in the early stage of gonorrhœa, and its pre-eminent advantages in leucorrhœa, go to confirm the same philosophy (§ 150, 151). This substance has no astringency, in the proper acceptation, but operates in its own wonderful way in breaking up the inflammatory state upon which the discharge depends.

890, *n*. And then as to leucorrhœa. How badly is this affection often treated by astringents, internally and externally, and also by tonics! And all this, mainly, because the disease happens to have, for one of its symptoms, a discharge from the vagina, and is supposed to depend upon debility of the general system, and relaxation of the mucous tissue; a sort of mechanical exudation from a flabby membrane that tonics and astringents may condense and strengthen (§ 409 *i*, 410, 569). But, if we look at the inflammatory nature of this affection, there will be no difficulty in understanding how these agents, and the usual stimulating diet, inflict their injuries. And now, if we consider that cantharides is the best internal remedy for leucorrhœa, another luminous guide will be obtained to a right apprehension of

the mode in which astringents may check, for awhile, those discharges which they may ultimately increase, or others, in other cases, successfully and permanently.

890, *o*. Let us now consider the remarkable manner in which certain agents will arrest a copious excretion of sweat, and we shall learn still more distinctly the nature of astringents, and their modes of operating; and thus be guided to the only intelligible purposes for which they should be employed, and carry this knowledge throughout the breadth of the Materia Medica.

Thus, then; here is a patient affected with pulmonary phthisis, who rises in the night to shift his wet for dry linen. But this inconvenience may be stopped at once by a few drops of sulphuric acid; and opium will often do the same. The acid and the opium, however, produce very different impressions; though each arrests the sweating by certain vital impressions. One may be beneficial, while the other is injurious, and vice versa, according to the exact combination of pathological circumstances when the agents are administered. In other diseases, and where the skin is dry, opium will induce perspiration; and it accomplishes this through the same laws as when it arrests the excretion. And, if we now observe the apparently contradictory philosophy when opium simultaneously checks the products of the liver and kidneys and increases that of the skin, we gain yet farther light as to astringents, penetrate to the common laws which are distinguished by opposite results, and go to the work of cure as the mechanic when he elicits countervailing movements from a common principle, or a common power, whose attributes are known (§ 863, *d*).

The vegetable kingdom supplies many astringents from which a substance is derived under the name of *tannin;* and hence, in part, the physical rationale of their modus operandi upon living beings. It is supposed that their astringent virtue resides in this tannin; and this may be so where the principle may be elaborated. But, there are numerous substances of active astringent virtues from which nothing analogous to tannin can be derived; such as the acetate of lead, and, indeed, all the mineral substances belonging to the group of astringents. We see, therefore, that the effect of the astringents themselves is not due to any coincidence in the constitution of these substances; and yet, notwithstanding the great differences among them, they may all bring about a common result (§ 150).

It is not alone to certain pathological states that result in redundant effusion that astringents are applicable. Certain conditions of inflammation, especially of external surfaces, are often greatly relieved by their local action. Acetate of lead is one of the best remedies, externally applied, for inflammation of the skin, of the eyes, &c. Sulphate of zinc, also, for conjunctivitis, the mineral acids or vegetable astringents for inflammation of the tonsils. These are active astringents, and the variety in their effects, according to the nature of the pathological conditions, whether employed internally or externally, declare their physiological action, and call upon the practitioner to study well the capabilities of each one. Nay, more; their variety of action when applied externally is not less than what we have seen from their internal administration. The acetate of lead, for example, may speedily relieve certain conjunctival inflammations, when such modifications of inflammation would be greatly aggravated by the sulphate of zinc;

but, in another case apparently alike, the sulphate of zinc will answer a better purpose. The nitrate of silver, however, or blisters, or leeches, may answer well for all the modifications. But here is a case, apparently the same, in which all the foregoing means have failed entirely. On pushing inquiry, however, we learn that in the generation preceding the last there prevailed the scrofulous diathesis. We accordingly resort to iodine, and the inflammation yields as under the influence of some magic power (§ 137 *e*, 150, 151, 851 *b*, 863 *d*).

Now, it is of vast practical importance to consider that the foregoing differences in results depend mostly upon slight shades of difference in the inflammatory states in the several cases (§ 150, 662, 673). And who can mistake the common nature of the modus operandi of all the agents employed (§ 137, *e*)?

890, *p*. It is important, therefore, to consider, that no two astringents are exactly alike in their effects, and that the property which is recognized as such may be associated with other active virtues in the same substance, by which the astringent is variously modified; while, as in compound medicines, the several virtues act as a whole, that which is most predominant giving the greatest determination to the nature of the impressions that may be produced (§ 188½ *d*, 889 *k*, 892). This variety, therefore, adapts these agents very variously to different forms of disease. When, therefore, a pure astringent is only required, such as may possess tonic or stimulant virtues should, obviously, be avoided. Remarkable examples of this nature, associated also with other virtues, occur in rhubarb, cinchona, the muriated tincture of iron, &c. Hence there is a great range of choice among remedies which may be selected to answer the intention of an astringent, in its strict acceptation. This has been already variously illustrated, as in the example of rhubarb. But we will have an exemplification in the Peruvian bark, an infusion of which, on account of its specific febrifuge virtue, would be exactly adapted to diarrhœa attendant on intermittent fever; or quinine, perhaps, would be preferable if the disease be recent. In such cases a pure astringent would be useless; which farther illustrates the operation of astringents, as it does, also, the distinctions between tonic, astringent, and febrifuge virtues.

But, the foregoing are broad shades of difference in pathological conditions. In very many cases where there is a great approximation in the pathological states, in many modifications of inflammation, it is often important to apply a certain remedy of astringent virtue in preference to others.

890, *q*. We may now see that certain astringents may be best suited to certain organs to which they are addressed than to other parts (§ 133, &c., 140, 150).

But these agents are so much circumscribed in their uses, that it is no longer an object to pursue the inquiry. What has been said, is more with a reference to bring these remedies within the pale of medical philosophy, and to illustrate that philosophy; and, in so doing, to prevent their misapplication. Those which are associated with other virtues are mostly wanted; such as rhubarb, cinchona, the sulphates of zinc and copper, &c., and these, mainly, for the sake of those virtues.

PERMANENT TONICS, AND DIFFUSIBLE STIMULANTS.

890½, *a*. Tonics may be regarded as a counterpart of the antiphlogistics. From the circumstance, therefore, of the latter occupying the high places in the materia medica, we may come, at once, to the conclusion that the former are comparatively of very limited importance. Indeed, it is only in the advanced, or in the declining stages, of acute diseases, or in certain states of chronic affections, that tonics can render much service.

No remedial agents, however, have been more extensively employed, and therefore none which have been so extensively injurious (§ 569, *e*). This misapplication of the Materia Medica has arisen, as in other cases, from erroneous theoretical views of disease, and mistaken notions of the modus operandi of remedies (§ 854 *bb*, 863 *d*, 892 *b*, 904 *d*).

890½, *b*. In considering the uses of tonics, it should be borne in mind that they have but a very limited range of curative influences; and that, in a general sense, they do but invigorate organic actions which have been reduced by prolonged disease, and where there is either no great amount of absolute disease, or where nature is already in the way of the restorative process, or where that process may only require an invigorating impulse to start it into existence. Such are the uses of tonics.

By now regarding the true mode in which these intentions are accomplished, and the absolute influences which are exerted by tonics, we shall come to a just apprehension of their relations to morbid states, and be better qualified to avoid them where they may be injurious.

890½, *c*. Tonics are commonly supposed to act upon mechanical principles, by bringing into close apposition the molecules of which the living tissues are composed, and attempts have been lately made, as at former times, to demonstrate the truth of this conjecture by experiments upon dead tissues (§ 569, *b*). This has led many to confound the virtues of tonics with those of astringents. But, we shall find that here, as in all other cases, Nature is consistent, and that tonics bring about their results like other remedial agents; that here, as in all analogous instances, there is no departure from Unity of Design (§ 137, *e*). A few plain illustrations will place the operation of tonics in its proper aspect.

890½, *d*. Thus: on referring to an example already stated for another purpose, we cannot fail to observe that the increased warmth of the skin, and muscular vigor produced by animal food as soon as it enters the stomach, are due to the same causation as the analogous effect of alcoholic stimulants, and that both must be expounded upon vital principles (§ 512, *b*). Those speedy effects manifestly depend upon vital impressions exerted upon the mucous tissue of the stomach, and their transmission by the nervous power to other parts. They are variously pronounced according to the exact combination of circumstances. The food will display itself most distinctly in such as have suffered its privation, and where the surface is chilled; the wine where it is least employed (§ 635, &c.). By varying these incidental influences, a corresponding variety will obtain in the results. Employ the food or the wine in febrile and inflammatory states, and the same demonstrations take their rank among the violent phenomena of disease. Now, here is the whole principle which is relative to the action of

tonics. These agents produce the same effects as the foregoing causes. They are the same, or sufficiently so for my present purpose, in the natural state of the body, and are modified in the same manner when employed in fever and inflammation. The fatigue incident to hard labor is at once relieved by nourishment or by wine. The influences here are exactly analogous to the vigor which is imparted to the voluntary muscles by tonics in cases of indigestion. In the former case the powers of the stomach and the animal frame have sunk under fatigue (§ 855); in the latter from disease. The food and the wine in one case exalt those conditions; and, from the analogy in the influences which are established by tonics in the other, we know that a common mode of action has obtained throughout (§ 137 *e*, 151). But, the tonic goes yet farther, and brings about a change in the organic state of the stomach, since food will not remove the condition upon which its indigestion depends. The tonic, therefore, is an alterative stimulant. In all the cases the voluntary muscles are suddenly or gradually invigorated by sympathetic influences propagated from the stomach. It is the same with the tonic as with the food or the wine. No sooner has the dyspeptic swallowed the first dose of bark than he tells us that his strength is coming as by enchantment. The tonic, also, like the wine, increases the desire for food; and if this effect can be no more interpreted by the physical doctrine than the former results, it may be safely concluded that every other problem offered by tonics falls within the philosophy of vitalism (§ 500, 516 *d*, no. 6).

It is now an easy matter to institute analogical demonstrations of the physiological operation of tonics, as in former cases, that of astringents, for example (§ 890). For this purpose ipecacuanha and the nitrate of silver may be taken; neither of which has any tonic virtue, while the former is contra-stimulant. But these agents are appropriate to the same states of indigestion as the tonics, and bring about the same results (§ 904, *d*). Or, take a moral cause for an exactly similar parallel, which may be seen in the effects of some agreeable intelligence, which, no one can mistake, has imparted, on the instant, a keenness of appetite, a vigor of digestion, and an exaltation of muscular strength, which had not been enjoyed for a month or a year (§ 137 *e*, 227, 512, 514 *h*). Or, place the same individual on board a vessel, or give him an airing by land, and the first hour, perhaps, will have brought with it far greater improvement of digestion and of muscular strength, than would have been imparted by cinchona, or any other tonic, in a month (§ 150, 657 *a*, 847 *g*, 856 *a*).

890½, *e*. As to the extent in which tonics may act as alteratives, that, as in respect to all other remedial agents, will depend upon the departure of the organic properties and actions from their natural type. As in all other cases, also, the useful effects will depend upon the nature of the morbid changes. But these conditions, in their relation to tonics, are not often constituted by any great deviations from the natural states. In most other instances tonics are morbific (§ 137, *e*). If they happen to be useful in active forms of disease, it is a random hit (§ 756). Their operation, however, even then, comes under the same principle as when they produce favorable results upon chronic derangements (§ 901). Sometimes, therefore, when active disease becomes prolonged, and the susceptibilities of the parts affected turned a little from the incipient pathological state, and under the influ-

ence of vital habit, tonics will prove less frequently detrimental, or may be so far curative that we venture to associate them now and then with the direct antiphlogistics, to obtain their mixed influence. It is often useful to combine them, especially the vegetable, in the form of infusion, or, perhaps, of tincture, with the mild cathartics that are adapted to the advanced stages of disease, just as we have seen of the union of rhubarb with saline purgatives (§ 872, *a*). In such cases, they not only prevent any prostrating effects of the cathartic, but are positively remedial, by going to the vital condition of organs (§ 137 *d*, 150, 569 *c*). And here, as in the case of rhubarb (§ 872, *a*), we may reverse the order of indications, and suppose that a tonic may be useful if it can be prevented from stimulating injuriously. This object may be often attained by uniting a mild saline cathartic, or, perhaps, a little tartarized antimony with the tonic remedy. This practice, in respect to antimony, is often highly useful in the treatment of intermittent fever, where the tonic virtue of cinchona, or quinia, interferes with the febrifuge virtue; while, at the same time, the antimony does its important work as an antiphlogistic alterative. Both of the agents, in these cases, are principal remedies. But it is the febrifuge, not the tonic virtue, which makes a salutary demonstration. The former is positively morbific, and may not only defeat the febrifuge action without the counteracting influence of antimony, but aggravate greatly the whole condition of disease. And this, by the way, is a distinct exemplification of the existence of those two opposing virtues in cinchona; while in the other forms of disease it shows itself in the aspect only of one of the best tonics (§ 137 *d*, 150, 535, &c., 672, 673, 675, 756, 847 *g*, 848, 854, 863 *d*, 867, 889 *k*, 890 *b*).

890½, *f.* But I say, again, that these agents are never wanted, in their relation to diseased states as tonics, in the early stages of any disease whatever; and, however they may now and then succeed (§ 756), they are generally prejudicial. If employed in certain forms of fever or inflammation in which tonics possessing febrifuge virtues, like cinchona, are not indicated, they endanger life (§ 150, 569 *e*, 621 *a*, 652 *c*, 662, 847 *g*, 848, 863 *d*). I think I shall have justified this assertion throughout the extent of these Institutes. But, in failure of this, I have only to point out the results of the Brunonian doctrine of disease, which prompted the tonic and stimulant treatment to so great an extent that it has been computed to have destroyed a greater number of the inhabitants of Europe, in the first forty years of its prevalence, than all the wars of that sanguinary period (§ 621, *a*).

890½, *g.* There are great resemblances between the virtues of tonics and diffusible stimulants, in their common acceptation; but there are also important distinctions. In instituting comparisons, therefore, between them, or of all other remedies, they should be regarded in their just relations to morbid states; for in this adaptation can they be alone remedial. We shall thus find that both classes of remedies are more or less applicable to the same conditions of disease, and that, on account of the differences that exist in their remedial virtues, it will be often useful to combine them together (§ 863 *d*, 889 *k*, *l*). In their proper therapeutical acceptation, tonics make their impression much more gradually, and more permanently, than diffusible stimulants; observing, in this respect, the same distinction that subsists between animal and vegetable food (§ 441 *c*, 890½ *d*). When, also.

tonics are useful, their effects are far more profound than those of diffusible stimulants. But this is not true of their morbific effects under circumstances of existing disease; since wine, and especially more ardent spirits, taken in any acute inflammation or fever, produce not only their usual more rapid impressions, but exasperate the morbid states to far greater degrees of intensity than any of the permanent tonics. The principle holds, also, in chronic diseases when tonics or stimulants prove morbific (§ 137, *d*).

The foregoing peculiarity of tonics fits them admirably to certain chronic forms of disease where the strong influence of a long-protracted morbid habit is to be surmounted (§ 535, &c.). Stimulants will not reach these conditions with sufficient alterative effect, or they may act with too much rapidity where a diseased habit is obstinately established, and where long-continued organic actions of a morbid nature can be surmounted only by the slow operation of favorable causes. But, in these obstinate conditions, the permanent tonics may not act with all the rapidity that may be useful; and then we associate some of the transient stimulants with them, by which the morbid states are rendered more susceptible of the effect of the tonic remedy. Or, more strictly speaking, the morbid conditions are brought more speedily by the stimulant into a close relation with the virtues of the tonic (§ 137 *d*, 889 *k*, *l*).

Again, however, some of the tonics possess, also, the virtues of transient stimulants, such as the cinchonas; and these compound attributes suit them well for those conditions of which I was last speaking, or for irritable states of the stomach when tonics are wanted, but are apt to nauseate (§ 150, 889 *k*, 890 *b*). In these conditions, a cold infusion of cinchona, whether as a febrifuge or as a tonic, surpasses its alkaloids on account of the presence of a volatile oil by which the stomach is promptly and gently stimulated, and thus enabled to bear the tonic influence of the bark.

890½, *h*. The suggestions which have been now made let us at once into the reason why all the tonics and stimulants may be converted to useful purposes in disease, and why it is greatly otherwise with cathartics and emetics. In the last instances there are far greater diversities in their curative and morbific virtues, and they are far more of an alterative nature than such as appertain to tonics and stimulants. There exist, indeed, among cathartics and emetics, many agents that can rarely be applied to any morbid conditions without increasing the existing evil or engendering new ones. In this respect, all the tonics and stimulants, when employed in active febrile or inflammatory states, are on a par with the most irritating cathartics and emetics. Their effect then goes deep; which admonishes us, more and more, to study well the relations of remedies to diseased conditions, and to discard all the conclusions which have been drawn from an observation of their effects upon man in health (§ 137 *d*, 150, 662 *a*, 675, 854 *bb*).

Nevertheless, the same principle of diversity applies to the several members of the classes of tonics and stimulants; but it reaches them in a very inferior degree (§ 52, 650). Since, therefore, there are no groups of remedies so closely allied in their virtues throughout as tonics and stimulants, there are none which, throughout, bring about results in the treatment of disease that so closely resemble each other (§ 863, *d*).

We thus come to understand why all the substances which compose the classes of tonics and stimulants may be more or less useful, and that no one of them is an excrescence upon the Materia Medica; notwithstanding the vast abuses to which they have been subjected, and the immense mortality of which they have been the subordinate causes (§ 569 *e*, 621 *a*). We are also thus led to the knowledge that one tonic, or stimulant, will often answer a better purpose than another; and we find, on applying ourselves to an observation of Nature, that experience confirms all the other premises. We have just seen an example of this in cinchona, and it is a striking general distinction, that the vegetable tonics are best adapted to the prostrate conditions which follow long-protracted acute diseases, while the mineral, especially the preparations of iron, are suited to chronic maladies, such as indigestion. Here, however, the vegetable tonics may be equally appropriate, while the mineral ones are not so to the direct sequelæ of acute maladies.

NARCOTICS.

891, *a*. Narcotics are agents which affect, especially, the nervous centres, and are, therefore, also denominated *cerebro-spinants*.

In my *Arrangement of the Materia Medica*, I have divided them into six groups or orders, according to their special influences upon the nervous system. Narcotics stand in a group by themselves; and the remaining five consist of *antispasmodics*, *tetanics* or *cerebro-spino-excitants*, *moto-paralyzants*, *senso-paralyzants*, and *cerebro-spino-depressants*. These distinctions are more or less observed by others.

Some of the narcotics, however, possess also the virtues of other groups, and vice versa; and, therefore, in conformity with this compound endowment, the same agents appear under the several appropriate denominations.

891, *b*. The most useful of the narcotics are the great agents by which pain is immediately assuaged, restlessness subdued into tranquillity, and wakefulness converted into refreshing sleep. Such, therefore, may be taken as the definition which I apply to narcotics, and it is obviously relative to different virtues in each individual substance, whatever may be their resemblance.

But, all narcotics do not equally produce their several effects. Some of them are more remarkable for diminishing and relieving pain, and are called *anodynes* (§ 194, &c.). Others produce sleep more particularly, and are known as *soporifics*. Others allay irritability and diminish vascular action, local and general, in a more decided manner than the rest, and are called *sedatives* (§ 188, &c.).

Such are the denominations in common use; but they are somewhat defective. All the soporifics, for instance, are also anodynes, and most, though not all of the anodynes, are more or less soporific. There are, also, many sedatives which do not rank at all among the narcotics; to which, indeed, the most powerful do not belong, such as bloodletting, hydrocyanic acid, tobacco, &c., and of which bloodletting is the only one of much value in the treatment of disease, but that one emphatically and justly denominated the *remedium principale*. The sedatives, therefore, which fall under the denomination of narcotics, possess, also, anodyne or soporific virtues.

891, *c*. We have seen how extensively large classes of remedies

have been perverted in their uses, and have yet to consider the no less common neglect or misapplication of bloodletting. There is no other way of enforcing their claims to a just consideration. In respect to the agents now before us, there is a yet smaller class who are equally unhappy in their estimate of their virtues; and, while the *stimulating* school exhaust the energies of Nature by adding to the intensity of disease in their peculiar way, the *narcotizing* school do the same mischief by a similar neglect of the pathology of disease; and what in either case should be attacked by the lancet, cathartics, antiphlogistic alteratives, &c., is roused into greater immediate violence by tonics and stimulants, or indirectly by other morbific influences which appertain to the narcotics (§ 150, 151). Take, for example, the opinion of the able and distinguished London physician, Dr. Sigmond, who says that,

"*Of all the different classes of medicine we possess, we may safely consider the narcotics, skillfully, judiciously, and watchfully administered, the most important.*"—SIGMOND's *Lectures in London Lancet*, 1836–7, p. 216.

The foregoing affirmation shuts out, of course, bloodletting, cathartics, all the important and numerous agents which I have grouped under the denomination of alteratives, as inferior, in therapeutics, to opium, hyoscyamus, &c. (§ 854 *bb*, 857).

On the contrary, I shall have endeavored to show, in various parts of this work, that narcotics are but little more than humble auxiliaries to more important remedies, and then only in a comparatively small number of the cases of disease; or, that they are mere palliatives, giving a temporary ease by blunting sensibility, where death is probably inevitable, and thus easing the sufferer out of existence.

891, *d*. That narcotics are extremely deficient in curative virtues should be sufficiently apparent from what has been already said of the uses to which they are constantly applied. But, even these intentions can be rarely well fulfilled by narcotics where much disease is present. We must then resort to the class of antiphlogistics for our great curative means; and, if the narcotics be summoned to their aid, it should be done with the greatest caution, or they may prove fatally morbific. We may exhibit opium, &c., for the relief of mere spasm of the stomach, to procure rest, &c., where no important acute disease is present. But he who should employ them to assuage the pain of pleuritis, enteritis, or any other active form of inflammation, and, in a general sense, of chronic forms, would either most seriously aggravate the disease, or destroy the patient (§ 150, 151). Whenever, also, there is any affection of the head, or any tendency to cerebral disease, so great is the liability of narcotics to induce congestion of the brain, that they are totally inadmissible where that organ is increased in its susceptibilities (§ 137, *d*). And then let us consider their never-failing effect, in their ordinary doses, of so injuriously modifying the action of the glandular organs, that the secretions of the whole, especially of that most important organ the liver, are more or less diminished; whereby Nature is obstructed in one of her greatest processes, natural and curative, and morbific influences thus reflected upon all diseased parts, and upon the whole organism (§ 862, 863). Should there be simultaneously set up in the skin a perspirable action, it is not of a salubrious nature; and here, again, we see demon-

strated the evils that arise from regarding the product and not the nature of the action upon which it depends (§ 512 *b*, 863 *d*, 902 *g*). Hence has arisen the pernicious custom of depending upon the compound powder of ipecacuanha as a principal curative means in the treatment of fever. The opium still inflicts its morbific effects upon the glandular organs and nervous system; being scarcely modified for the better through its union with ipecacuanha, even in its greater determination of diaphoresis.

891, *e*. In respect to the modus operandi of narcotics, I shall now only lay down the proposition that these agents produce their salutary or their morbific effects, like all other remedies, or all other causes of disease, and set forth the proof in other appropriate places (§ 891½ *h*, 904, &c.). The principle involved is so perfectly in harmony with all physiological facts relative to the healthy state of the body, and supported by all the well-ascertained facts in medicine, that it enables us to comprehend how it is that one drop of the tincture of opium administered by the stomach will afford more relief to one man than fifty drops will to another, or how that one drop of laudanum will do more injury in the former case, than fifty will in the latter, where the conditions of disease are exactly alike, but where the doctrine which I have advanced expounds the difference in effects upon natural physiological differences in the constitution of the two individuals,—just as common sense does when an oyster is nutritious to most people, but poisonous to a few (§ 191, 447, 585, 904 *b*).

The failure of narcotics to produce the same effects when applied to the trunk of a nerve as upon its expanded extremities is a prominent fact in humoralism, and has contributed largely to the doctrine of remedial effect by absorption. The fallacy of the whole philosophy is indicated in other places (§ 826, *d*, &c.).

891, *f*. The effects of narcotics generally decrease, respectively, when frequently repeated, or when habitually employed at more distant intervals (§ 558, *a*). But the organic properties, as in their relation to all vital stimuli, whether remedial or morbific, maintain about their usual susceptibility to all narcotics except the one in use; and it is therefore often advantageous to change from one to another, or to employ two or more in combination (§ 150, 151, 650, 889 *k*). And here I may remark how a single fact proves that remedies operate upon the system at large by sympathy.

We have hitherto seen that an admirable variety of virtues appertains to many of the different members of each group of remedies, by which they are extensively adapted to various pathological conditions that approximate each other, but which are marked by such differences that, were each group composed of only one or two agents, we should be constantly baffled in the treatment of disease (§ 889, *k*). And, how vastly, in this respect, has the Materia Medica been improved in recent times by simplifying certain substances of compound virtues, attended, also, with much excrementitious matter; as in the examples of many alkaloids, iodine, &c.! Opium, for instance, is generally inadmissible in inflammations, unless to moderate irritability of the intestine, in muco-enteritis, or of the lungs, in pneumonia, or after the disease as affecting some other parts shall have been subdued by bloodletting, cathartics, &c. But morphia may be very appropriate when opium itself would be detrimental (§ 863, *d*). If nei-

ther, however, be admissible, we possess in hyoscyamus, or conium, or lactucarium, or lupulin, or churrus, &c., substitutes which may be often employed with advantage. So, again, belladonna, aconite, stramonium, render, each one, their peculiar services in certain painful affections, or other conditions of disease, or subserve some purpose in surgery. As these last three, however, possess no soporific virtue, but lead to sleep by assuaging pain and irritability, they are included in my arrangement of narcotics upon that principle of indirect effect.

891, *g*. The most extensively useful effect of narcotics is that of procuring sleep; so great is the tendency to wakefulness in diseases, and so pernicious is its presence. This, too, depends greatly upon age; children requiring a great amount of sleep, while four or six hours will commonly answer for manhood and more advanced age. This is for disease. Rather more than the maximum is wanted in health. The law of adaptation comes, here, into operation, in morbid states, as with all things else (§ 137, 847 *g*, 848, 859, 863 *d*, 870 *aa*).

But, before the administration of narcotics for the purpose of procuring sleep, we should look well to the cause of the wakefulness; for the loss of blood, or a cathartic, or an emetic, or greater abstinence from food, &c., may be the appropriate means. When, however, narcotics are adapted, their effect is peculiarly happy, not only in relieving and aiding Nature, but in promoting the operation of other remedies (§ 137 *d*, 150).

891, *h*. We are often required to witness an obstinate wakefulness, arising more from anxiety, or other affections of the mind, than from the disease itself; and when the day comes, the first glance of the eye upon the sunken or ghastly features of the patient may awaken apprehensions for which there is no just foundation. Now let the window-shutters be closed, exclude all unnecessary attendants, let the nurse be seated quietly in a chair, lay aside medicine and even food, take down the bed-curtains, ventilate the room, but not from a window that may throw a blast upon the patient, graduate the bed-clothes to his sensations, moderate or put out the fire, and if the patient have not rested when night comes on again, give him an anodyne narcotic, keep all things quiet, and, at our morning call, we shall be likely to understand the reason why narcotics are so improperly administered when wakefulness arises from profound disease, perhaps of the brain, or when sleep is ample, but pain and suffering call for a relief that narcotics may not yield. It is the delightful effect of these agents, in the case which I have just supposed, and where preliminary means for tranquilizing the system have been adopted, that often leads the inattentive observer of the pathology of disease to their indiscriminate use; and his blindness is frequently such, and so great may be the quiet and insensibility that the narcotics produce, that the patient may drop into the grave without raising the suspicion that he was doomed by the narcotic.

What I have just said of quiet, darkness, &c., are exceedingly important auxiliaries to soporifics, and should be carefully directed. They are causes, too, which should awaken attention to the modus operandi of active remedies, whereby the necessity of the latter will be greatly diminished. Choose, also, the night, when possible, for the exhibition of anodynes; not only on account of its greater stillness than the day, but because this is the natural time for sleep (§ 137, *e*).

891, *i*. The next great use of narcotics, in an absolute remedial sense, relates to their power of diminishing the *irritability* of disease; whether local or general (§ 188, &c.).

Irritability is augmented in inflammations, and it may be important to allay it by narcotics; not only to enable Nature to take on the cure, but to prevent the undue action of exciting causes (§ 137 *d*, 150, 645 *c*, 855). Thus, it may be very useful to exhibit morphia in pneumonia, after bloodletting; by which the cough may be more immediately assuaged than by the loss of blood. But narcotic means are more admissible, and far more useful in inflammations of the intestinal mucous tissue, than of any other organ. Here, too, in various states of the alimentary canal, narcotics may often precede advantageously the administration of cathartics, or be associated with them; and, in a general sense, hyoscyamus is by far the best. In this case we lessen the irritability of the intestinal mucous tissue, and thus prevent the cathartic from doing mischief to the part (§ 889, *k*). So, also, in dysentery, opiates are often given to allay the irritability of the part inflamed; even when no other internal remedy may be employed. Or, it may be to prevent any irritation from small doses of ipecacuanha, or calomel, &c. But when opiates are employed in such affections, the doses should be small, and repeated, if necessary. Larger ones prove morbific. In serous inflammation of the bowels, on the other hand, they are entirely inadmissible (§ 137, *b*, &c.). But, it not unfrequently happens, that active inflammation seated in some circumscribed part of the intestinal mucous tissue induces spasmodic action in the contiguous muscular portion, which cathartics never fail to aggravate. In these cases, a moderate dose of opium may relieve the spasm, and result in free dejections. Hence opium, with some, has been actually supposed to be invested with the power of cathartics.

Nevertheless, opium should be always cautiously exhibited in all cases of the foregoing nature; but, with this reservation, they are likely to prove highly salutary in very many instances. But, it is, in all such instances, only a subordinate agent; and it will be often far better to accomplish our purpose of obviating the apprehended bad effects of a cathartic, or any other remedy that may be likely to irritate the intestinal mucous tissue, by the general or local abstraction of blood, or by vesicating the abdomen. It should never be overlooked, that the most that is accomplished, in such cases, by opium, or other narcotics, is that of diminishing irritability; while the other means produce great remedial effects.

At other times, morbid irritability may be general; but this is commonly attended by restlessness, and watchfulness. We then employ narcotics with the double intention.

891, *k*. Next in order comes *pain*, depending on exalted or morbid sensibility. This might appear to call more frequently and imperiously for narcotics than wakefulness or the irritability of disease. But it is otherwise; though it is for the relief of pain that narcotics are most abused, and where they do their greatest injury. Whether they will be now beneficial, will depend upon the cause of the pain, its seat, and other circumstances. If owing to active inflammation, they will be likely to aggravate the disease in most parts, but not in all. And here we learn the vast importance of a critical knowledge of the special vital endowments of the different tissues, and of a studious reference

to the seat of disease, as well as a critical examination of the attendant symptoms, since the pain of mucous and serous inflammation of the intestine may be exactly the same, and opiates curative in the former, but certainly fatal in the latter (§ 133, &c., 150, 685, 686). Here, too, in the mucous tissue, they accomplish the double purpose of reducing irritability as well as sensibility (§ 150, 188, 194). In the other case, or that of serous inflammation of all parts, if they render sensibility obtuse, they increase and otherwise injuriously modify the irritability of the part, and thus aggravate the disease. In the same general sense, also, opiates are more or less suited to inflammatory states of the whole mucous system.

891, *l*. But, the great agent for the relief of pain attendant on active inflammation of any tissue is bloodletting; and this, particularly, when the disease affects any great vital organ. In a general sense, also, the less important the part, the safer will narcotics be in inflammatory affections, whether acute or chronic; though, in these cases, care should be taken that they are not contra-indicated by obscure conditions of disease in the complex and great organs of life (§ 150, 689 *l*, 863 *d*). And here it is well to remark, that the organs most important to life are far from being most liable to pain. This is true of the lungs, in pneumonia; and the liver, also, is but little subject to pain in any of its diseases, while the pleura, or peritoneum, or thecal membranes, the ligaments, &c., are never much inflamed without great attendant suffering. The urinary and generative organs are liable to very painful affections; and here, most happily, narcotics are very often admissible in their acute inflammatory diseases. So, also, they afford immense temporary relief in pain of the stone. They operate like a charm in cramp of the stomach, and in the suffering attendant on the passage of a gall-stone along the ductus choledocus. In these last cases the narcotic is directly curative by relieving spasm.

When pain attends chronic affections, narcotics may be administered with less hesitation; but still with a careful reference to the seat and nature of the disease. They are of the greatest value, as palliatives, in the pain of cancerous affections, and generally for the suffering attendant on the chronic maladies of most parts that have not strong sympathetic relations to important organs (§ 725, 859 *b*).

891, *m*. It may be said, in connection with the foregoing subject, that pain is very rarely a cause of disease, but may increase the force of such as may be present. But, even in these cases, the aggravation of disease is owing more to the general disturbance inflicted, and to privation of sleep, than to any direct influences upon the part affected. Great suffering may exist without disturbing even the action of the heart, if the subject be firm of endurance. If the general circulation be disturbed as the apparent consequence of pain, it is moral emotion, not the pain, which produces the phenomenon (§ 167 *f*, *note*). Indeed, the true philosophy of life conducts us to the above conclusion, since the property upon which pain depends is not an element in the organic functions (§ 194, &c.). In the foregoing manner, or through the medium of the various mental emotions it produces, pain may aggravate or develop an attack of disease; and it is through the medium of the cerebro-spinal axis that it increases disease without the intervention of the passions.

The power of endurance, and, therefore, the degrees of injury which

pain may inflict, depend greatly upon temperament, and the general condition of the constitution as arising from disease, habits, culture of mind, &c., and these contingencies affect, also, the susceptibility of the vital states. Much, too, will depend upon the *kind* of pain; and the kind, also, has its important influence in directing the treatment.

891, *n*. Owing to the prevalence of sympathies, the patient is often liable to be deceived as to the true seat of pain; and an inattentive or ignorant physician may be thus led into the greatest mistakes (§ 526 *d*, 891½ *b*). Diseases of the liver, for example, give rise to pain in the right shoulder, which opium may relieve, while it would aggravate the hepatic affection. Or, if he apply a blister, or other agents, to the shoulder, they will be useless. But, if placed over the seat of the liver, they will be more or less likely to relieve the remote sympathetic affection. This, also, enlightens us as to the importance of addressing our remedies, in all cases, mainly to the organs upon which sympathetic developments depend, and where they may remain under the influence of the primary affection (§ 689 *l*, 905).

891, *o*. We see, therefore, that blisters are among the great means of assuaging pain; but, like bloodletting, they operate in a very different manner from narcotics.

There are, also, other agents not of the class of narcotics, which are remarkable for their control over the pain of particular modifications of inflammation, such as colchicum, guaiacum, &c.

Hence we see, more and more, the uncertainty of pain as a guide to treatment, and that our remedies should be mainly determined by other considerations. Nor will I neglect the opportunity of saying how deeply all this subject relative to pain, wakefulness, &c., and the counteracting influences of the narcotics, should impress us with the futility of the chemical and physical philosophy of natural and morbid processes. From what we have seen, too, of the great variety of means by which pain may be assuaged, we come to an unhesitating conclusion as to the modus operandi of narcotics.

891, *p*. There is one agent not yet mentioned, which is often very remarkable for the relief which it affords in tranquilizing restlessness, allaying pain, and in procuring sleep; while it has also the great advantage of being generally free from objection. This is the warm bath; or analogous means in the form of warm fomentations and poultices. By these means intestinal pains, strangury, the intense suffering from sprains, painful menstruation, &c., are frequently dissipated at once. Again, refreshing sleep may be often induced by the warm bath, when narcotics fail, or would be injurious (§ 150, 863 *d*). These agents are also curative in a direct manner; but variously so, according to the nature of the affection and the degree of heat employed. The bath at 105° or 110° F. frequently, perhaps daily applied, establishes such impressions upon the skin that highly salutary influences are often reflected upon some chronic forms of hepatic and intestinal disease.

As farther illustrative of the remedial nature of narcotics in relieving pain, and as contributing to many general objects in the philosophy of life, I may advert to the manner in which certain affections of the mind arrest intense suffering, remove wakefulness, &c. This is strikingly shown in the sudden subsidence of toothache when the dentist is expected, and in the relief which follows the exercise of

charms, &c. Certain sounds, also, by awakening agreeable emotions, produce similar results; as variously observed in the effects of music, the monotonous bubbling of the brook, the clanking of machinery, the rocking of the cradle, &c. (§ 137 *e*, 150, 151, 227).

891, *q*. Narcotics are generally directly sedative, though there is sometimes a temporary excitement of the general circulation. But, their great effect, and which is positively conclusive of their sedative action, consists in lessening irritability and sensibility in a direct manner. Nevertheless, opium is considered by many as the most powerful stimulant; which shows the importance of correct views in the philosophy of life.

891, *r*. Narcotics generally produce their effects with rapidity, so that when their repetition is indicated for immediate purposes, the intervening time need not be long. And this leads me to advert to the remarkable manner in which pain often counteracts the sedative effect of narcotics, and enables the patient to bear a quantity that would be fatal in health. The solution of this problem is even beyond the compass of the physiologist; nearly as much so as that of sleep (§ 137 *e*, 150, 151, 175 *c*, 500 *n*).

Certain special affections of the nervous system also counteract the usual effects of narcotics in an astonishing manner; as seen in delirium of drunkenness.

891, *s*. Finally, habit, in respect to the use of narcotics, is very remarkable. Instances are authenticated in which the habitual use of opium has enabled individuals to carry it to the extent, daily, of more than three hundred grains. Solidism and vitalism point to correspondence between the general results and the amount of impression upon the stomach for an interpretation of the philosophy.

ANTISPASMODICS.

891½, *a*. Two principal objects are contemplated in rendering the antispasmodics a subject of consideration. First, to aid in illustrating the philosophy which concerns the nervous power; and, secondly, to indicate their misapplication in many conditions of disease.

891½, *b*. The group of antispasmodics embraces all the narcotics, and regards them in the special acceptation which it is my present purpose to consider. As the term implies, they are employed for the relief of spasm, and, mostly, of the voluntary muscles. Now these agents are very commonly applied for the relief of the symptom, and with too little reference to the fundamental cause. Thus, Dr. Paris says that "*Spasm may arise from excessive irritability, as from teething, wounds, worms, &c., in which case a narcotic would prove beneficial*" (§ 526 *d*, 676 *b*, 891 *n*). I have taken this illustration because it is quoted by others as a good example of spasm where the narcotic antispasmodics may be properly employed. But, to my mind, all the conditions which are here stated very rarely admit of relief from narcotics, and are often aggravated by them. The spasm imputed to teething may depend upon a variety of pathological causes, however the irritation of the gums be a concurring cause. If it be due alone to dentition, lancing the gums is the remedy. If to intestinal disease which is maintained by teething, the remedies are then the foregoing and others of greater importance relative to the abdominal affection, such as calomel, castor oil, warm fomentations to the abdomen, &c.

If narcotics be now employed, it is for the purpose of allaying intestinal irritability, and not at all with a view to their direct action on the cerebro-spinal system. As to spasm from wounds, the narcotics have been most extensively tried and abandoned as useless, excepting where they are slight; and then, more relief may be procured by a warm poultice applied to the wound. If worms be the cause, we ought surely to look for the remedies among the anthelmintics (§ 150 526 *d*, 891 *n*, 859 *b*, 863 *d*).

891½, *c*. Antispasmodics have been largely employed in *hysteria*. But here they have been almost as fruitless as in the spasms of children; though, perhaps, not so detrimental. Hysteria, in numerous instances, is so dependent on some external derangement, and this condition so often consequent on visceral disease of the abdomen, that the treatment should be, in such cases, of quite a compound nature, but in which antispasmodics can take no useful part. An emetic, however, in a general sense, will afford temporary relief, which it accomplishes in part by modifying the several conditions of disease, and in part through influences which are called into operation in suspending a paroxysm of spasmodic asthma, and hiccough, as explained in section 514, *c*.

891½, *d*. *Chorea* is another complaint in which antispasmodics have been extensively employed, and with as little reference to the cause of the symptom. They have, therefore, failed, or have left the patient for the worse. Abdominal disease being at the foundation, the remedies should consist of cathartics, a well-regulated diet, exercise, and change of air (§ 150, 863 *d*).

891½, *e*. But, worse than all, antispasmodics have been in high repute for epilepsy; notwithstanding their universal failure to afford any relief. The disease, however, is attended by spasm, and the symptom, as in the other affections, has been taken for the disease, and no small amount of suffering and death have been accordingly inflicted by antispasmodics. In many cases, this affection depends, immediately, upon cerebral congestion; and then bloodletting, mostly, is the proper remedy. At other times it is owing to a transient sympathy of the brain with an overloaded stomach; when a mild emetic is the sure antispasmodic. At other times the sympathetic disturbance of the brain depends upon profound disease of the liver and other abdominal organs; and here, cathartics of calomel, &c., and doubtless bloodletting also, are the appropriate means. Again, it depends upon organic disease of the brain, or on a spicula of bone projecting from the dura mater, or on depression of some part of the cranium.

The foregoing are almost all the causes of epilepsy; from which it results that antispasmodics should have no place among the remedies for this affection (§ 150, 847 *g*, 848, 859, 863 *d*, 870 *aa*).

891½, *f*. Congestive asthma, the usual form of the disease, has had its full share of the antispasmodics, and, of course, with as little benefit as they have yielded to the preceding affections. They are more or less appropriate, however, to the rare form of spasmodic asthma; but here an emetic is often better, or a pipe of stramonium leaves may answer (§ 514, *c*). But congestive asthma depends upon something more than simple irritation of the nervous centres. There is a highly-injected state of the venous system of the lungs, consequent on disease of the abdominal viscera, involves many important organs, and

calls imperatively for bloodletting, and cathartics (§ 150, 786, &c., 847 *g*, 848, 859 *b*, 863 *d*, 870 *aa*).

891½, *g*. Any empyrical practice is admissible in hydrophobia; but the most empyrical of all have been the efforts to cure the disease by antispasmodics.

891½, *h*. We may now call up our recollection of the various properties appertaining to the narcotics, as set forth in former sections, and we shall readily see that they must be commonly injurious in most of the diseases which give rise to spasms.

891½, *i*. But there are some agents which are mostly antispasmodic, in their relation to the nervous system, such as asafœtida, musk, valerian, &c. These agents are known as the true antispasmodics, although opium greatly transcends the whole in its virtue of arresting spasm. But those of simpler virtues are very circumscribed in their morbific relations to the brain and to other organs, and exert but little effect as therapeutical agents (§ 150). This leads me to consider the remaining object of the present inquiry (§ 891½, *a*).

891½, *k*. No one can mistake the immediate bearing of the whole of this subject upon the general philosophy which concerns the modus operandi of remedial and morbific agents, while the function of respiration, and other natural processes, display the physiological laws under which the former are directed (§ 462–475, 495–534, 639 *a*). Although, therefore, the phenomena of spasm form so luminous a guide through the whole labyrinth of sympathy, and impart a peculiar interest to the discovery of Sir C. Bell in relation to the different orders of nerves (§ 462–470, 476 *b*), we need not be long detained in making the contemplated exposition.

In the first place, then, we observe that the irritation of the nervous centres may be either direct, as in severe forms of epilepsy (§ 891½, *e*), or indirect, as in the more compound and ordinary process of remote sympathy (§ 227, 230, 500). In the former case the nervous power is developed in a direct manner, either in virtue of some disease affecting the nervous centres, or by some direct mechanical irritation, as in depressions of the skull-bone, projecting spiculæ of bone, and extravasated blood (§ 476–494). In the latter case, the primary irritation is in a remote part, as in the gums, or intestinal canal, &c. (§ 891½, *a*). In this instance, the impression is transmitted through sensitive nerves, to the nervous centres, where it operates as an exciting cause of the nervous power, and is exactly equivalent to the direct irritation of those centres; as observed in the former case. The residue of the process then becomes alike in both the cases. That is to say, the nervous power is reflected through motor nerves, or motor fibres of compound nerves, upon the affected muscles, and thus are they thrown into spasmodic action (§ 230, 233, 500).

Such, again, are all the elements; and since they are now in operation in their morbid aspect, we have the plainest demonstration that the whole process depends upon natural physiological laws.

And now, briefly, for the opposing or curative influences. We have seen that when the simple antispasmodics arrest the movements, they institute mild impressions only upon the nervous centres; but they must necessarily modify the nervous power in its very nature, or they could not arrest the movements of the muscles; since it is the nervous power which now operates, and upon exactly the same mus-

cles in which it had developed the spasmodic action. In one case, therefore, it acts as a stimulant, in the other as a sedative. Nothing in mathematics can be more absolute (§ 150, 227–232, 433$\frac{3}{4}$, 481–491, 493, 494). The same results attain, also, when the narcotics operate in simply removing spasm. But these are agents which embrace other virtues that are very apt to prove morbific (§ 891, *d*), and their morbific impression may be transmitted from the stomach to the nervous centres, especially on account of their specific relation to the nervous system (§ 137, *c*), without first engendering or increasing disease in the stomach or other parts (§ 502, *c*), or, there may happen along with this a direct morbid change in the condition of the stomach (§ 502, *c*), or indirectly, through the increased morbid change in the nervous power, in other parts. These new conditions of disease may aggravate the spasmodic affection; since the nervous power is not rendered sedative to the affected muscles (§ 150, 228 *b*–232, 233$\frac{3}{4}$); or, on the other hand, the morbid change may be of such a nature as to break up the special condition of the nervous power which gives rise to the spasm, and thus put an end to that part of the malady, although there ensue a very aggravated state of disease (§ 890, 900, 901, &c.). Thus we see presented the compound aspect of a remedial agent bringing about relief to one part of disease, or removing one symptom, and simultaneously aggravating or inducing disease in other parts, and increasing all other symptoms. The principle is distinctly the same, throughout, as when the narcotics, or simple antispasmodics, establish that change which results only in the removal of spasm. We are, therefore, presented in the examples before us, as a general ground for the interpretation of morbific and remedial agents, the union of the physiological, morbific, and remedial processes.

From the foregoing facts and philosophy we might reason safely to the modus operandi of all other remedial and morbific agents, especially in connection with the natural processes of sympathy (§ 500), had we not about the same amount of concurring proof in the manifestations of every other cause (§ 893, *motto*).

CINCHONA, AND ITS ALKALOIDS.

Tuto, cito, et jucunde.

892, *a*. As an interesting incident in the history of this extraordinary agent, it may be said that the Peruvian bark was not introduced into Europe till the year 1640, or more than one hundred years after the full conquest of Peru; which is abundantly conclusive that all the alleged connections of the savages, lions, and vultures, which continue to appear in works on the Materia Medica, are wholly fabulous. It was not, however, till a century afterward, or in 1738, that the plant became known to naturalists, through Condamine, the French savant. His account of the tree appeared in the Memoirs of the French Academy, along with the story about the lions. Condamine says that the Countess of Cinchona, wife of the Viceroy of Peru, carried the bark to Europe in 1640; from which circumstance, and from her previous connection with the introduction of the bark into use, as stated by Condamine, Linnæus immortalized her name. The countess brought the bark into use in Peru by a first experiment upon herself, at the suggestion of the Corregidor of Loxa. She then transferred its patronage to the Jesuits; when the bark dropped the name of the "Count-

ess' powder," and became known as the "Jesuits' bark." It would be an entertaining inquiry to follow the history of cinchona after its introduction into Europe. No article of the Materia Medica has employed so extensively the pens of medical philosophers, and under every aspect of praise and condemnation, and of angry controversy; and next to this, that now universal luxury of man, the nicotiana tabacum. Before the time of the alkaloids, Von Bergen published the names of more than six hundred authors whose writings he had consulted on the subject of the Peruvian bark, and refers to eight hundred distinct treatises upon this remedy. Subsequently to that period, the discovery of the cinchona alkaloids, and their application as therapeutical agents, have given rise to so vast an accumulation of books, pamphlets, and memoirs, that the writings upon this single article of the Materia Medica would, alone, form a library of very imposing dimensions. And yet do I find myself at the threshold of another paragraph upon what should seem so completely exhausted. I shall therefore endeavor to turn myself upon that track which has been least pursued, and which, as in many other cases, is too often abandoned,—the path of Nature.

The bark, having been early carried from Spain into Italy, it may be well supposed that a country so liable to intermittents, and those, too, of the most formidable character, would soon illustrate the virtues of this extraordinary febrifuge, and enlist in its favor the most powerful patronage. About this time, however, it was called to encounter one of those checks which it repeatedly afterward underwent with less disaster, and which will remind us of what has befallen the philosophy of medicine in the laboratory of a German chemist. I shall therefore state it, in the hope, at least, that it may go with the rest in promoting independent habits of observation (§ 349 *d*, 350, 350½).

The commendations which the bark received from the priesthood, and the popular appellation of the "Jesuits' bark," were not sufficient to establish its success in countries less scourged by malaria than the Peninsula; for even in Spain the physicians were either disposed to reject the remedy, or to meet it with opposition. But, its demonstrations were such in the Italian climate, that Pope Innocent the Tenth made it the subject of a papal communication to the Church, and co-operated with the Italian physicians by directing the publication of their report; in which the curative virtues of the bark were set forth with all the confidence that has been warranted by subsequent experience.

The medical document which was thus promulgated was called the "Schedula Romana," and contained directions for administering the bark as to time, quantity, &c.; the established dose being two drachms of the powder.

This Schedula soon became a target for those who had been hostile to the bark; and the warfare was begun by one who had professed to have entertained prepossessions in its favor. This individual, whose name was Chifletus, was prompted in his opposition to the bark by its partial failure in a case where it was important for the physician to have obtained more complete success. A relapse, however, ensuing at the end of a month, the chagrin of the physician led him to denounce the remedy in such violent terms, that it lost, at once, many of its firm friends, and rekindled the animosity of its opponents.

Chifletus boldly assumed that all the Roman and other encomiums were mere pretense, and that the bark was not only useless as a remedy for fever, but absolutely pernicious, and should be utterly proscribed by the profession. He challenged any well-authenticated cases of cure; and by this arrogant style he attracted the attention of no small part of Europe. The credulous came to believe his assertions, and the evil-disposed united in a crusade against the tenant of the Andes. Chifletus was hailed as a great public benefactor, as "the Reformer" of the day, in having relieved the world of a scourge. His publication was reprinted in the languages of different European countries; and, for awhile, the whole profession appeared to acquiesce in the justice of the decision.

Nor was this condemned article ultimately rescued from the trammels of ignorance and prejudice by its proper guardians; but by a learned Jesuit, who once more bore it aloft by unequivocal proof of its extraordinary control over the great bane of Italy. From that time, opposition became more and more feeble, and the merits of the remedy gradually established.

But, this is only a passage in the early history of the Peruvian bark. It was not, like the tobacco, required to encounter the edicts of despots, though it equally underwent the ordeal of a fierce disputation; and it is scarcely possible for us, who now contemplate these two remarkable members of the vegetable kingdom with the calm indifference of long and universal experience, to appreciate the uncertainty in which their virtues were held, or the angry and vindictive reproach to which that uncertainty gave rise.

We see, also, in the nature of the hostility which was for awhile waged by a great part of the profession against this invaluable remedial agent, and in the very face of its triumphant success, a disposition to trample upon the best interests of society, where it may seem expedient to bow to the dictates of a despotic writer, or where professional pride, or cunning jealousy, or malevolent envy, may hope for gain. Nor can we fail to observe in this extraordinary and almost universal denunciation of the Peruvian bark, as a curse which was scarcely exceeded by pestilence, a striking parallel with the furious opposition which bloodletting has been required to encounter.

It is also an interesting, as well as instructive, coincidence, that while Sydenham was storming the prejudices against the *remedium principale*, in the treatment of inflammations and fevers, he was also employed in combating the opposition to the bark, which had become very general in England. He triumphantly set forth the advantages of the former, and compelled his obstinate cotemporaries to acknowledge the healing virtues of the Peruvian febrifuge. But, to the Pontine marshes of Italy we may refer the stability which was first bestowed upon the bark. Here were perpetually emitted the seeds of intermittents, which were now, for the first time, eradicated extensively by the all-potent drug.

892, *aa*. In my Arrangement of the Materia Medica, I have grouped together, in the order of their therapeutical value, many agents which are peculiarly appropriate to intermitting forms of disease, and, into this group no other remedies are admitted. They possess, therefore, what are commonly denominated specific virtues in relation to the diseases to which the group refers. This, indeed, may be more

or less affirmed of all the other groups, excepting those of a common antiphlogistic nature. It is not, therefore, to be inferred, when the remedies for any given character of disease are specifically indicated, that there may not be others that are more or less appropriate, but which are not included in the group before us (§ 137 *d*, 150). Cathartics, even, are liable to this qualification; since, without previous bloodletting, they will often aggravate disease. But, after applying the former remedy, the cathartic may cease to be necessary. The loss of blood has accomplished all that was contemplated from the internal agent; but bloodletting cannot be arranged among the cathartics.

So, again, in certain conditions of amenorrhœa, it may be obvious that guaiacum will establish menstruation after the loss of blood from the arm, or after a purgative, but would be injurious without. Either of the last remedies, however, may supersede the necessity for the first, or reputedly specific. And so of its special relation to gout, &c. It is the same as more extensively considered under the group of astringents; and the same remarks are precisely applicable to the group of remedies now before us, of which cinchona and arsenic are the principal.

I have thus shown the general bearing of special groups, that it may be seen that there is nothing remarkably peculiar in the principle which governs the applicability of specific remedies, as they are called, to intermittent diseases; unless it be, that, in these cases, the virtues of the remedies have a remarkable bearing upon the remote causes of intermittents. Nevertheless, it is here, as in all other cases where agents of special remedial virtues are employed, others of a more general nature are often indispensable to give effect to the special ones, and very often, very generally, I may say, to render them operative, or to prevent their detrimental effects.

892, *b*. But, as no intelligible use can be made of remedial agents without a knowledge of their mode of operating, and as we are supposed to be profoundly in the dark in relation to the therapeutical effects of cinchona, I shall first have a few remarks upon this important subject (§ 890½, *a*). Our admitted ignorance of the rationale, as of all other remedies, aside from the chemical doctrines, is thus expressed by Pereira in his Materia Medica. Thus:

"*I have hitherto referred to those indications only which have an obvious relation to the known physiological effects of cinchona. But, the diseases, in which this remedy manifests the greatest therapeutic power, are those which assume an intermittent or periodical type. Now, in such, the methodus medendi is quite inexplicable.*"

Such, again, is the abandonment of physiological laws and principles the moment we pass from the simple processes to others in which those processes undergo changes that are brought about by precisely the same causes (§ 493, 514½ *b*, 530). But, cui bono? Where is the practical use of physiology, if we thus abandon Nature, and repose quietly in a state of ignorance as to their relations to disease and the manner of cure (§ 639, *a*)? I shall, therefore, I say, bring up this subject, of which we are so confessedly ignorant, again and again, in the hope that, by thus presenting it in its proper connections with physiological and practical matters, we may gradually come to recognize its importance to the healing art.

I shall reserve, however, the critical analysis of the modus operandi of cinchona and arsenic for the general summary which is yet before us; and therefore will now refer the reader to a subsequent section (§ 904, *d*) for that part of my inquiry which would otherwise be presented in this place. We discern, at once, from what is there said, especially in connection with all the other analogous facts, how strangely astray from Nature is every physical and chemical doctrine which now encumber the philosophy of medicine.

Having thus divested this plain affair of the mystery which has been thrown around it, and seeing clearly the simple principles through which all remedial effects are produced, we may bring the philosophy with no little aid to our experience in the treatment not only of intermittents, but of all other diseases.

892, *c*. The considerations to which I have now referred, along with what is known of the peculiarities that appertain to the virtues of every remedy, and how those virtues may prove morbific as well as salutary, enable us to understand the favorable and unfavorable relations which cinchona, or arsenic, may bear to the different stages of a paroxysm of intermittent fever, when to apply the remedies and when to withhold them, how they may aggravate any coexisting local congestion or inflammation, or how, from our knowledge also of the modifying effects of the remote causes, these agents may, at other times, arrest the local as well as the general disease, or how other agents, like bloodletting, will place the unfavorable states in a favorable way for the action of the tonic febrifuge (§ 150, 675, 847 *g*, 848, 857, 859, 863 *d*, 870 *aa*). We learn, also, from the same considerations, and from what is set forth in section 904, *d*, that no remedies can be properly regarded as specifics, neither cinchona, arsenic, &c.; since, from the vast variety and contradictory nature of the means by which intermittents may be arrested, we may clearly perceive that no one of these causes exerts what is understood by specific effect. The several means, however, arrest the disease; and they do it by instituting such changes in the diseased conditions as place them in the way of restorative changes (§ 672). Each one, however, determines changes according to its own special virtues, and in no other sense are they specifics. So far, then, they are exactly on a par with any other remedy, and with every cause of disease (§ 52, 150, 151, 650, 892$\frac{2}{3}$ *d*). But, this peculiarity of virtues is more strongly pronounced in some things than in others, and is seen remarkably in cinchona; as in its profoundly morbific effect during the hot stage of the febrile paroxysm, and its equally curative demonstration during the period of intermission. Here, too, I may again say that its mode of operating at these successive stages of one and the same disease is distinctly seen to be of a common nature (§ 675, 891$\frac{1}{2}$ *k*). Here we have not only a consistent philosophy throughout, but, also, in that philosophy and the attendant facts, a fountain for many practical conclusions; such, for instance, as the importance of bringing about, in a general sense, distinct intermissions, before resorting to what are emphatically denominated remedies for intermittents; and that it would be improper, in a general sense, to employ the agents now under consideration, in remittent fever, or, at most, not till the febrile action has been modified by direct antiphlogistic means (§ 150, 847 *g*, 848, 857, 859 *b* 870 *aa*).

Nor may we begin, precipitately, the treatment of intermittents by cinchona, nor by any agents of the present group, simply because it is an intermittent, and there happens to exist that suspension of febrile action which is known as the period of intermission (§ 689 *l*, 890 *d*, 891 *k*, *l*). There may be present some local congestion or inflammation, that may demand the abstraction of blood; and the general condition of things will rarely fail of requiring a cathartic, at least. But, it often happens before any preliminary treatment may have been adopted, that an intermission is pretty strongly pronounced, and yet that the intensity of the febrile condition is such as to raise apprehensions that the patient may be destroyed by the violence of the next paroxysm. These are frequently cases for grave deliberation, whether we shall abstract blood, or administer a purgative, or an emetic, or proceed at once to the employment of bark. If no important local disease be present, some eight to fifteen grains of calomel should be given, followed soon by an appropriate dose of castor oil, and, in the mean time, the sulphate of quinia should be exhibited till the next paroxysm takes place. It will not do to prostrate the system in these cases by an emetic. In the way now suggested, however, we may stay the violence of the approaching shock.

On the other hand, if there be any serious amount of congestion in the liver, or inflammation of the intestinal mucous tissue, as commonly happens with the liver especially, we shall accomplish nothing by this early use of the bark, in these concentrated forms of fever. Either trust alone to the cathartic till after the next paroxysm, or bleed the patient also. There is no "debility" in the case. Keep the eye on the pathology. Nature may rise up at once under the lancet, when she would sink under an emetic, or the tonic virtue of the febrifuge (§ 150, 569 *e*, 576 *e*, 847 *g*, 848, 857, 859 *b*, 863 *d*, 870 *aa*, 961, 962).

892, *d*. Having brought the system into a condition for the administration of cinchona, or some of its preparations, we are next to ascertain which of the two methods should be adopted; for there are two modes of treatment having essential differences.

One of these methods consists in making a very strong impression, at once, by a single blow, as it were, upon the diseased conditions, during the intermission, by the administration of a large dose of bark, or of quinia (as five or ten grains of the latter), and thus endeavoring to arrest the fever at once.

The other method is one of greater moderation; the remedy being exhibited in small quantities (as that of a grain of quinia), at intervals of two to four hours, throughout the intermission.

By the latter process, the alterative action is more gradually exerted; so that the paroxysms may continue to recur an uncertain number of times, but with diminished intensity, till, at last, they disappear.

And now as to the relative advantages of the two methods. In the first place, we can readily understand, theoretically, that the precipitate course, by large doses, may exasperate any coexisting inflammation or venous congestion; and yet, from the difference in the pathology of fever and inflammation, the former condition may be overthrown.

We know, also, that it will not answer to arrest the fever suddenly by arsenious acid; because a large dose of that remedy may inflict a far greater evil than is constituted by the fever. Such, in fact, is the

negative reason; for an excessive dose of arsenic may arrest the complaint at once. It is only, therefore, its liability in large doses to inflict other mischief, that prompts its administration in small doses. And just so it may be with cinchona, or its alkaloids, and their salts. In the former case, the morbific effects are strongly pronounced, and the agent is not prescribed at random. But, it is quite otherwise with the large doses of quinia. The attending venous congestions, which are very apt to be present (and far less frequently other forms of inflammation), may be increased and established without manifesting any striking phenomena to admonish a hasty practitioner of the mistakes he may have made (§ 790, 795 *b*, 798, 801, 806, 807, 811, 815, 816, 961–964, 967).

Now, experience shows exactly what theory, suggested by the true operation of remedies, rendered more or less probable. Experience, I say, shows that, though bark, and its alkaloids, in large doses, will often arrest intermittent fever suddenly, such doses are liable either to induce some congestion, especially of the liver or of the mucous tissue of the stomach, or will aggravate and establish some coexisting congestion; and thus, while the patient is, for the present, relieved of the fever (§ 904, *d*), he is dismissed with an insidious local complaint that not only renders him a permanent invalid (resulting often in indurated enlargements, § 803), but which local malady may, and often does, become, in a process of time, the exciting cause of another attack of fever; thus showing, also, that the predisposition to the constitutional disease remains, although the paroxysms, and therefore its absolute condition, were interrupted (§ 150, 560, 665, 666, 779, 904 *d*).

In other words, while we thus inflict a useful and sudden blow upon the fever, or general malady, through one virtue of the bark, we lay the foundation of a local disease, through the tonic virtue, in itself perpetually harassing, undermining the constitution, and not unfrequently so establishing the predisposition to fever, that the patient will continue to suffer returns of it from time to time, during the residue of the brief period of life which an indiscreet practice not unfrequently allots to him. He is but "imperfectly cured," as Celsus has it; and these imperfect cures become the slow cause of those chronic enlargements of the liver and spleen for which iodine is especially beneficial. In respect to relapses, it is not infrequent that, when intermittents are suddenly stopped by a large dose of quinine, the paroxysms return as soon as the patient begins to exercise much, or to take his ordinary food,—certainly with far greater frequency than when the case has been treated upon the moderate system (§ 847 *g*, 848, 857, 859 *b*, 870 *aa*, 878).

It is now interesting to remark that the plan of large medication is apt to be adopted by those practitioners who are least inclined to recognize bloodletting as of much importance among remedial agents, or who discern in the philosophy of disease any other elements than debility and something in the blood to be expelled or neutralized (§ 569, 960).

On the other hand, when the gradually alterative process is pursued, the patient is not only about as expeditiously relieved of the fever, but, also, of his local congestions; for, Nature has now a chance to throw off these more obstinate affections (§ 904, *d*), which she is greatly disposed to do while undergoing the gradual removal of the febrile

action; so only we do nothing to interfere with these local salutary efforts (§ 662). But, there is also the more important advantage resulting from the negative fact of not directly increasing, or actually producing, congestions by the milder system of treatment.

According to this plan, certain other objects of the highest importance are not as likely to be overlooked as when its antagonist is brought into action. It presupposes a tolerable regard for the existing state of the pathological conditions before the treatment is begun. Some care is taken that all congestions or inflammations of important organs are so far mitigated by bloodletting or cathartics, or by antimonial alteratives, and the intensity of the fever so far subdued by some one or more of those direct antiphlogistics, as shall render the tonic febrifuge not only safe, but speedily curative (§ 150, 151, 847 *g*, 848, 857, 859 *b*, 863 *d*, 870 *aa*); for speedy it will almost always be when its administration is proper, and the case continues to be judiciously treated. If the intermissions be not well marked, there probably remains some special burden of disease upon the stomach, or liver, or other important organ, which should be yet farther mitigated before the use of the tonic febrifuge is begun; although, as already seen, it may be sometimes employed in cautious doses where the local inflammations and venous congestions have refused to yield to bloodletting, cathartics, antimonials, &c., and even now and then, at rather advanced stages of the disease where the paroxysms run into each other (§ 662). In all such cases, however, we should move on with great circumspection; never employing the agent of tonic virtues till it become apparent that this form of fever, and its local complications, are not likely to surrender to the direct antiphlogistic means (§ 870 *aa*).

Among what may be considered the subordinate remedies, but which are truly among the most important, are perfect rest in bed, and a total privation of stimulating and solid food during the existence of the fever, whatever may be its prolongation. It is astonishing, I say, what an important agency these two negative remedies exert. The objectional food either stimulates injuriously if it be of an animal nature, or, if vegetable, it irritates the stomach mechanically; while the erect posture, if long continued at least, proves in other ways an exciting cause. And then, as to all those things which so falsely pass under the denomination of refrigerants, such as the acid of lemons, oranges, &c., they never fail of so irritating the intestinal mucous tissue as to aggravate the symptoms which they are intended to assuage. A cathartic, or bloodletting, are the only things that deserve such a name, unless it be ice; and even in regard to ice itself, either of the first means may prove far more refrigerant to the organic being (§ 150, 151, 440 *e*, no. 14, 441 *c*, 442 *b–e*, 443 *c*, 447 *c*, *d*, 447 *h*, 447½ *f*, 863 *d*).

A proper want of attention to food, and fatigue from exercise, during convalescence, are the great causes of the relapses which take place after well-treated cases of intermittent fever. Almost any thing will arrest the paroxysms, when applied under favorable circumstances. And just so it is on the other hand; almost any thing unduly applied will reproduce them while the predisposition is strong, as it commonly is for some time after their subsidence.

892, *e*. In the quotidian form, I commonly exhibit one grain, in solution, of the sulphate of quinia every two or three hours during the

intermission. In many of the cases the patient does not suffer another paroxysm after the preliminary treatment, and beginning the use of quinia; but, in a majority of instances, he has another paroxysm, but of great comparative mildness. This, however, is almost invariably the last of the fever.

In the treatment of tertians, the intermission being longer, more time is allowed for producing the requisite impression by the quinia, and I therefore take no unnecessary risk of aggravating, or of producing any local forms of disease, but administer the sulphate of quinia in doses of one grain once in three or four hours; and I continue this regular exhibition of the remedy throughout the night. In a vast majority of these cases, there has been no return of the paroxysm after beginning the use of the quinia—so only the fever have been a regular tertian, and the intermission well marked. But absolute rest, and a fluid, farinaceous diet, till there is a failure of the periodical return, are a sine qua non.

892, *f*. The various means which I have now stated as to the treatment of regular intermittents, with the exception of cinchona, are still more important in remittent and continued fevers; and their importance increases in the ratio of the intensity of any local inflammations and congestions of important organs. The former affection is now far more apt to spring up than in intermittent fever, especially in the continued form; while venous congestion is the predominating condition in intermittents and remittents.

892, *g*. When the hot stage of an intermittent is unusually prolonged, I have found it most useful to employ not more than half a grain of quinine at a dose; and, in remittents, of the most formidable nature, after repeated abstractions of blood, and the exhibition of cathartics, especially of calomel, and alterative doses of tartarized antimony, I have in the end resorted to the sulphate of quinia in the minute doses set forth in section 870 *aa*, and patients have been thus rescued from otherwise inevitable death.

Here, too, as in numerous other gradations of febrile action, especially where the constitutional affection is not subdued into a distinctly intermitting form, or where it remains complicated with declining inflammations, quinine may be brought to bear advantageously in small doses, by associating with it the minimum doses of tartarized antimony, when the former agent would be otherwise morbific. The antimony lessens irritability, subdues arterial action, and thus counteracts the stimulant virtue of the tonic febrifuge, while it also reaches more profoundly by its alterative virtue. With the same counteracting influence tonics may be sometimes brought usefully to the aid of Nature; especially where unsubdued chronic inflammations are kept up by prolonged indigestion. So, again, cathartics, especially the neutral salts, may be added to tonics with the same double intention; or, on the other hand, tonics may be combined with cathartics to counteract the prostrating influence of the latter.

892, *h*. On the Continent of Europe, and in some parts of the United States, ten grains of the sulphate of quinia at a dose is common; and this explains the reason why an impression has obtained that this compound is apt to irritate the stomach, or to produce purging. If its full effects in such quantities were farther analyzed and better appreciated, we should also hear of them much more unfavorable reports.

892, *i*. The celebrated French writer, and admirable practitioner, Tissot, more than a century and a half ago, complained that the bark had suffered much in reputation from being employed in too small a quantity. The subject, in consequence, was subjected to the test of critical observation. The dose employed by himself, and which was about the same as sanctioned by the distinguished men of that age, was one drachm of the powdered bark. If the fever were of the tertian type, he administered eight of these doses during the intermission, or a dose every three hours. For a quartan, he prescribed the same dose, and at the same interval, so that, instead of an ounce, as in the tertian form, an ounce and a half would be taken during the period of intermission. "These doses," he says, "frequently prevent a repetition of the paroxysm." And this it would have done with greater success, had it not been the usage of those days to enjoin exercise upon these patients, and even to allow them solid food during the intermission.

As to the quantity of bark, Tissot gave the maximum dose that was mostly employed. This was considered abundantly large. Tissot, indeed, observes that, "The frequent failures of the bark are owing to small doses. On such occasions the medicine is cried down and condemned as useless, when the disappointment is solely the fault of those who do not employ it properly."

If we allow, therefore, the large proportion of one grain and a half of the alkaloids to one drachm of good bark, and that the febrifuge virtue of cinchona depends mostly upon these principles, we shall not have more than one grain at a dose in actual operation, on account of the nature of the compound. But, in a great proportion of the barks in common use, there is not the quantity of one grain of the alkaloids in a drachm of the bark. The crown bark of Loxa (C. Condaminea), an excellent species, and mostly in use in Tissot's day, has less than half a grain of the alkaloids to each drachm. These facts are of great practical moment, as it respects the important question now before us; as they come from some of the very best observers, men who would venture upon bloodletting whenever necessary, and who had the same question under consideration.

In Tissot's time, however, there were many who employed excessive doses of the bark, and thus injured or destroyed their patients. And this, of course, was another reason why the bark was often in disrepute. The alkaloids, it is true, are rather less morbific; but not at all so in the ratio of the moderate and immoderate practice. The consequences, therefore, are the same now as represented by Tissot, Morton, and others, in their times.

Be it also remembered, that they who are thus fearless of the cinchona alkaloids, and others who administer calomel by the table-spoonful in congestive fever, and tartar emetic in five to ten grain doses, repeated at short intervals, in the treatment of pneumonia, &c., are the very ones who most condemn the greatest, safest, and most speedy of all means for the cure of such affections. And just so, too, as in former times, the public, seeing the failure of their effects with quinia, and other powerful internal agents, as is very natural with a class so entirely uninformed of the true merits of the case, run to an opposite extreme, and imbibe a belief that medicines are hazardous unless in such small doses as shall exert no effect whatever. The

confidence of the public being thus more or less impaired in the whole profession, there will not, of course, be wanting those who, as in Tissot's day, will take advantage of this false conclusion, and will, as in former times, employ cinchona, and other remedies, in such minute doses as will render no aid to Nature (§ 854 *bb*, 878, 894, *mottoes*).

892, *k*. The large medication by quinia may be traced up, in part, to the analogous use of tartarized antimony in Europe. But, while the treatment of intermittents by doses of five and ten grains of quinia has extended from Europe to America, we have not kept pace with its progress there. How far this practice has had its origin in physiological or pathological facts may appear from some of the results which have been affirmed by its advocates. Thus, the distinguished M. Piorry, having embraced the opinion of M. Louis, that the enlarged and indurated spleen, a condition which often supervenes on neglected or badly-treated intermittents, is the cause of the fever, applied the treatment upon that hypothesis. Accordingly, we learn from M. Piorry the following results. In a patient, for example, affected with a quotidian, we are gravely told that,

"All the organs were HEALTHY, *except the spleen*, the length of which was seven inches and ten lines, breadth five inches and five lines."

To this patient, thirty grains of quinia were given at a dose, and in twenty minutes afterward the hypertrophied spleen was reduced more than one inch in its length and breadth, as ascertained by percussion; but which we may regard as physiologically impossible. Four days afterward, as the paroxysms still continued, M. Piorry gave this patient forty grains of the sulphate of quinia at a dose; and measured the spleen by percussion in twenty minutes afterward, and found it more than four inches shorter than when the first dose was exhibited! Other cases of the same nature are related, in which he administered sixty grains of the sulphate at a dose; with the never-failing effect of reducing the spleen at least an inch in all its dimensions within the regular time (twenty minutes) after the exhibition of the remedy (§ 854 *bb*, 857, 878).

These reports of cases have been extensively circulated, and incorporated into the "experimental philosophy" of the day. Sigmond has a salutary remark upon this subject, which may not be without its advantages in this place. Thus:

"He who has in early youth sedulously watched the practice of hospital physicians, and has heard from them the mode of management which was formerly pursued; he who has compared what he himself saw at that period, with what he gathers from the most eminent writers, and has then enjoyed opportunities of drawing his conclusions from the bed-side of patients, both in public establishments and at their own houses, will be able to appreciate the difficulties which occur in the application to practice of the rules that are laid down by some individuals with such dogmatic precision; he can also judge of the inutility of those theories which appear based upon plausible foundations, and which are often promulgated by individuals who hastily draw conclusions from few facts, and who commence explanations of their own views, ignorant of what has been thought, said, and practiced by some of the able men who have preceded them; who are again reviving doctrines which time and experience

have already demonstrated to be erroneous. *The disregard of physiology and pathology has been one of the great fallacies of the age in which we live. The devotion to morbid anatomy*, however praiseworthy is its investigation, has absorbed too much of the consideration of some of our most eminent medical philosophers. They have rather reasoned from the ravages which disease has committed, than from the signs and symptoms, and from the gradual development of the morbid functions of organs. Hence fever has been imagined to be a local disease, and hence the various theories have led not only to unsound, but, in my opinion, to dangerous practice." "The enlargement and induration of the spleen, which attend upon mismanaged intermittent fever, are not uncommonly produced by the neglect of the proper means previous to the use of cinchona, and by its administration in the wrong stage."—SIGMOND's *Lectures. London*, 1837.

892, *kk*. In what has now been said of the employment of cinchona with a special reference to chronic enlargements of the spleen (§ 892, *k*), it is not intended to be implied that the agent is not more or less adapted to such cases; as it is, also, to analogous affections of the liver, &c., which supervene upon intermittent and remittent fevers. But, in all such cases, there are other means not less important; such as a well-regulated diet of mild vegetable food, leeching and vesicating the affected region, the local or internal use of iodine, &c. In all such cases, however, the doses of quinia should not exceed one grain; and the practitioner and his patient must yield to the necessities of the case, and be content with advances toward a state of cure that shall correspond, in some degree, with the gradual progress of the disease from its incipient to its aggravated form (§ 150, 548 *a*, 557 *a*, 855, 856, 926).

892, *l*. Pereira has presented a good summary of the effects of quinia in the exclusive practice, as inferred from general experience. Thus:

"In doses of *ten* grains, sulphate of quinia has produced on man three classes of effects:

"1. Gastro-enteritic irritation, marked by pain and heat of the gastric region, nausea, griping, and purging.

"2. Excitement of the vascular system, manifested by increased fullness of pulse and augmented respiration. Furred tongue, and other symptoms of a febrile state, are observed.

"3. Disorder of the cerebro-spinal functions, indicated by headache, giddiness, contracted, and in some cases dilated, pupils, disorder of the external senses, agitation, difficulty of performing various voluntary acts, somnolency, in some cases delirium, in others stupor."—PEREIRA's *Materia Medica.*

Here, then, are a great variety of symptoms which denote the pernicious effects of quinia as having followed immediately its exhibition in doses of *ten* grains, and I have witnessed many of them from *five* grains only. But, it is these strong demonstrations only which are likely to engage the attention of a large class of practitioners, while the more obscure, but analogous effects of which I have spoken, pass unheeded, or are imputed to other causes.

892, *m*. Let us, then, look well to the preparatory treatment. Let us scrutinize the varied and exact pathology of the individual cases of intermittent fever; and clear up, at least, any local congestions

that are so apt to stand in the way of the tonic febrifuge. But, let us not neglect the important consideration that these local states are imbued with the special influences of the remote causes of the constitutional affection, and that they are more or less amenable to the Peruvian bark, and would, doubtless, be far more so but for the tonic virtue of the febrifuge (§ 650, 652 *c*, 662, 670, 814–816, 847 *g*, 848, 857). Where they are marked by periodical exacerbations, they may refuse to yield in their specific nature to all things else than some agent of very peculiar virtues; and here it is that cinchona, or arsenic, make their special demonstrations. But it is far from being certain that such agents are indicated because the local conditions of disease do not give way to a direct antiphlogistic treatment. It may be that this treatment has been imperfectly applied, that too little blood, perhaps, may have been abstracted, that leeching or blistering have been improperly neglected, or out of their relative order to general bloodletting and cathartics, or, that some untoward exciting causes, such as errors in food, or fatigue, &c., have been in operation to defeat the right influence of the principal remedies for inflammation. These are considerations of great moment, and should duly pass under review in all cases, before we summon to our aid the power in reserve; especially if the local symptoms do not fluctuate like the paroxysms of fever (§ 151, 675, 686, 847 *g*, 848, 870 *aa*).

Again, however, cases arise where the local affections put on a distinctly intermitting character. The symptoms of cerebral congestion rise and fall with the febrile paroxysms and the intermissions, or those of pleurisy undergo the same fluctuations. Here, therefore, there is little or no room for doubt, after a full impression has been made by bloodletting, cathartics, &c., upon the general pathological condition. This preparatory treatment adopted, the first moderate dose of quinine will often tell us that it has reached deeply the peculiar modification which had been impressed upon the congested or inflammatory states by the miasmatic cause; while, on the other hand, had the remedies for common inflammation been neglected, and no impression had been thus made upon the universal pathological condition, that grain, or less, of quinia would have exasperated the whole condition of disease (§ 137 *d*, 150, 151, 650, 672, 673, 801, 814, 857, 870 *aa*).

892, *n*. The foregoing peculiarly modified states of congestion and inflammation, in their supposed intensity (§ 892, *m*), are not, however, common in America; but, it is more common to find that remittent fevers, notwithstanding any remaining congestions with which they may have been complicated, will be ultimately benefited by very small and cautious doses of the cinchona alkaloids (§ 150, 870 *aa*).

892, *o*. It should be added that it has occasionally happened within the experience of the best observers, that acute and violent inflammations have occurred independently of intermittent fever, where the inflammation has refused to yield to bloodletting, &c., but has subsequently surrendered speedily to the bark. It can scarcely be doubted, however, that these rare conditions are under the modifying influence of the remote causes of intermittents (§ 150, 151, 813 *a*, 816).

892, *p*. Besides the affections which I have considered in the foregoing sections, there are others of an intermitting character to which the cinchonas, and their allies, are especially adapted. These are the well-known intermittent head-aches, intermittent neuralgia, intermit-

tent amaurosis, intermittent ophthalmia, &c.; all of which probably depend, for their specific character, upon the vegetable miasmata that lay the foundation of intermittent and remittent fever (§ 150, 650, &c.). Such has been the opinion of those who have lived and written in the midst of such affections. "The same cause," says Tissot, "which produces the intermittent fever, frequently occasions also disorders that return periodically at the same hour, without shivering, without heat, and often without any quickness of the pulse. Such disorders generally observe the intermissions of the quotidian or tertian fevers, but much more seldom those of quartans. I have seen violent vomitings, and retchings to vomit, with inexpressible anxiety, the severest oppressions, the most racking colics, dreadful palpitation and toothaches, pains in the head, and very often unaccountable pain over one eye, the eyelid, eyebrow, and temple, on the same side of the face, with a redness of that eye, and a continual trickling of tears. I have also seen such a prodigious swelling of the affected part, that the eye projected, or stood out, above an inch from the head, covered by the eyelid, which was also extremely inflated or puffed up. All these maladies begin precisely at a certain hour, last about the usual time of a fit, and terminate without any sensible evacuation, return exactly at the same hour the next day, or the next but one."

This reminds us of Hippocrates; and the practitioner in the malarious districts of the United States will not fail to recognize in the graphic portrait the same things in his almost daily walks, as he does in the "epidemics" of the venerated father of medicine.

The treatment of the foregoing cases is very embarrassing, unless we are prepared by a knowledge of their peculiar pathological character; and, having quoted the experience of Tissot as to their occurrence, I cannot do better than to state the treatment which was pursued by one who is so eminently entitled to our confidence; especially as that treatment has not been improved.

If the affection was decidedly inflammatory, as in the case of the eye, he abstracted blood. Then he goes on to remark that, "There is but one medicine that can effectually oppose these periodical maladies, which is the bark. Nothing affords relief in the fit, and no other medicine ever suspends or puts it off. But, I have cured some of these disorders with the bark, and especially those affecting the eyes, which happen oftener than the other conditions, after their duration for many weeks, and after the ineffectual use of bleeding, purging, baths, blisters, and a great number of other remedies. If a proper quantity of it be given, the next fit is very mild; the second is prevented, and I never saw a relapse in these cases, as often happens with intermittent fevers." But Tissot had, also, a preliminary treatment.

Tissot wrote before arsenic had come into use as a remedy for intermittent fever, and which has been subsequently employed with great success for the intermitting headache, &c.; though it is probably inferior to the cinchonas, especially their alkaloids.

892, *q*. There is one form of continued fever to which the bark is adapted in its advanced stages, and, what is remarkable, the tincture is often the best, and that, too, where stupor has come on, along with subsultus tendinum, black tongue, sordes, &c. This form of the continued fever is the typhus, and belongs to climates where the intermitting diseases are scarcely known to occur. In these cases, the

bark appears to act both as a tonic and febrifuge. But, it is only suited to advanced stages of the disease.

892, *r*. Whenever cinchona, or its alkaloids, prove beneficial under other circumstances than such as have been stated in the foregoing sections, they operate in virtue of their tonic property. But, like all other tonics, their range of usefulness, in this acceptation, is very limited; being suited only to advanced stages of acute disease, or to some chronic maladies in which digestion is peculiarly impaired, or to others attended by profuse mucous discharges, as in old and excessive bronchial secretion, old diarrhœas, &c. Their best effects as tonics are probably manifested in feeble scrofulous habits, when digestion is impaired; and along, perhaps, with iodine. They exert, also, a kindly influence upon the shattered constitutions of old venereal subjects, especially when mercury fails of its usual office, and then, also, iodine should often go with it. They are among the present helps to broken-down debauchees.

Notwithstanding, however, the inconsiderable advantages that arise from cinchona as a tonic, it stands at the head of that group of remedies, as it does in its rank among the special alteratives for intermittent diseases. The contrast in effects separates very widely from each other these coexisting virtues, while the limited advantages of one or its more frequent pernicious effects tell us, forcibly, to beware of the whole group of tonics.

ARSENIOUS ACID.

892¼, *a*. Arsenious acid, in the treatment of intermittent diseases, has been rapidly passing into the great reservoir of forgotten things; whither it has been driven by the power of novelty, and the superior excellencies of the cinchona alkaloids. But, it remains as ever a sure friend of man whenever his necessities may oblige him to call it from obscurity. It is partly from these considerations, and in part, to look at its peculiar attributes as a curative agent, and thus to elicit new rays of light upon organic life and the philosophy of medicine, that I shall venture to disturb the repose of this once busy member of the mineral kingdom.

But, these objects need not detain us long, as I contemplate a reference mostly to its relations to intermittent diseases; and much of what was said of cinchona is applicable to arsenic. This agent, however, is not complicated by any tonic virtue, as otherwise supposed by many, which divests it of objections that are relative to that characteristic of cinchona. But, it has the attribute of a violent poison, and may, therefore, be liable to disastrous effects from its incautious use. But, with this contingent objection, the amount of evil which it has inflicted is insignificant with that which is constantly in progress from the untimely application of the Peruvian bark, or from its excessive administration. In one case, the immediate evils are less striking, or creep slowly on; in the other, it is death itself who stands before us.

892¼, *b*. Arsenious acid appears to be more or less poisonous to all animals. In its therapeutical dose, it produces no apparent effect upon man in health; which is only one of the numerous facts that admonish us against all conclusions as to remedial agents from what may be witnessed of their effects upon the healthy system, and to bend

our attention to the properties of life as their susceptibilities may be affected in disease (§ 150, 854, 870 *aa*, 892½ *a*).

In respect to the manifestations of arsenic in morbid states of the body, independently of its curative effects, they may be sufficiently learned from a statement by Dr. Fowler, that, "in 320 cases, somewhat more than one third was attended with nausea; nearly one third with an open body; and about one third with griping. Vomiting, purgings, swellings, and loss of appetite were but rare in comparison with the preceding effects, and their less frequent occurrence was generally found in the order in which they are here enumerated. About one fifth of the cases attended with nausea, and one fourth of those attended by an open body, were unconnected with any other effects. Griping did not often occur alone. Purging and loss of appetite seldom or never alone, and vomiting was always accompanied with more or less nausea."

The foregoing observations unfold the nature of the general influences which may be more or less expected from the therapeutical dose of arsenic, and illustrate the fluctuating nature of the organic properties.

892¼, *c*. Fowler's Report upon the effects of arsenic appeared in 1786, and subsequent experience has amply established its febrifuge virtue. It appears, indeed, not only to have succeeded occasionally in the hands of most practitioners of experience where the bark and its alkaloids have failed, but even upon an extensive scale in certain epidemical intermittents. It owes, in fact, its early reputation considerably to its success in an intermittent fever which infested Great Britain about the year 1780, and which prevailed for more than two years. But, it was the obstinacy, more than the great prevalence of this epidemic, which renders it memorable; and this the more so from its resistance of the bark, and its submission to arsenic. This was one of the occasions in which the bark fell into considerable disrepute; and we now comprehend the reason of its frequent failure during the epidemic of which I am speaking. Bloodletting was not then the fashion in Great Britain, and this fever was attended by those local congestions and inflammations which either demand the loss of blood, or, at least, render it necessary to any safety in the early administration of bark. But this tonic febrifuge was administered without the requisite advantages of a preliminary treatment, and the local conditions of disease were accordingly exasperated, the fever aggravated and prolonged, and often rendered fatal by the very remedy upon which there was the sole reliance (§ 847 *g*, 848, 854 *bb*, 857, 863 *d*, 870 *aa*).

However, therefore, the bark may have been thus baffled in its effects as a febrifuge, and inflicted the evils of a tonic, it was no fault of the remedy, but of the practitioners, who neglected the true pathology of the disease, overlooked the local developments, and permitted their prejudices against bloodletting and cathartics to deprive them of the benefits which might have accrued from the Peruvian febrifuge. Being thus baffled in their attempts with an agent of tonic virtues, a few practitioners availed themselves of the reputation which arsenic had obtained in Poland as a febrifuge; and this substance being destitute of the tonic and stimulant virtues of cinchona, it was more compatible with the local condition of disease, and therefore succeeded in the

hands of those few better than the bark. It was apt, however, to occasion vomiting and purging; but these effects were mostly the consequence of a neglect of the appropriate means for subduing the force of the local burdens of disease.

Parallel with the foregoing is an opinion which is thus stated by Dr. Sigmond.

"The effects of arsenic are much more striking in the intermittent fever occurring during the autumnal months, than during that which is prevalent in the spring; and the more intensely the miasm has acted upon the system, the more decided are its good effects, while cinchona, and the barks of certain trees, produce their characteristic effects during the spring."—SIGMOND'S *Lectures*, 1837.

I have quoted this remark for the purpose of carrying out the views which I have expressed as to the failure of the bark in the English epidemics, and as it is its tendency, also, to encourage the use of arsenic in the autumnal intermittents, without any just ground for the conclusion as to its superiority over the bark in the fevers of that season. The greater success of arsenic as here stated has been observed only in the hands of those who administer the bark indiscreetly, and without properly subduing the local congestions and inflammations which are every where more common and severe in the autumnal than in the vernal intermittents. And, as one of the evidences that the greater success of arsenic, under the circumstances now stated, is due to the absence of the tonic and stimulant virtues of cinchona, I may quote the remark from Pereira that, "It is not necessary to intermit the use of arsenic during the febrile paroxysm. In agues, accompanied with inflammatory conditions, where cinchona and quinia disagree, arsenic may, according to Dr. Brown, be sometimes administered with the best effects."

Immediately after the events of the British epidemic of which I had been speaking, Dr. Fowler appeared with his "arsenical solution," or the liquor potassæ arsenitis; which has been supposed by many to surpass the arsenious acid in its remedial virtues. This preparation became the means of establishing, rapidly, the character of the new agent all over Europe.

892¼, *d*. The question arises, next, as to what conditions of intermittent fever arsenic is applicable in preference to cinchona. We have seen that the bark and its alkaloids are capable of surmounting the disease with great certainty and rapidity under its ordinary conditions when properly administered; and this qualification supposes that other remedies, such as bloodletting, and especially cathartics and antimonials, shall be brought into operation whenever demanded by the general or local symptoms. The disease, being thus treated according to its variable pathological conditions, and the Peruvian febrifuge withheld till its application is compatible with the pathological states as meliorated by the direct antiphlogistics, we may, undoubtedly, in almost all cases which are seen in their early stages, succeed completely with the alkaloids, and thus avoid a remedy, which, like arsenic, is liable to the objections of being fatal in the dose of a single grain, or of inducing violent symptoms, or of laying the foundation of other serious and even fatal affections, in its usual therapeutical doses, if administered in inauspicious conditions of the system, or when continued, under favorable circumstances, beyond a certain

period. These considerations leave no doubt, therefore, that the alkaloids should be first employed in every case of intermittents, whether they be of fever, or of those other local diseases having periodical paroxysms, as considered in sections relative to the bark. Such, indeed, were the conclusions of the soundest medical experience before the introduction of the cinchona alkaloids; and, while balancing the merits of these remedies, we cannot too well consider the safety of one when employed with a proper reference to pathological conditions, and the dangers of the other, under all conditions, that are liable to accrue from over-doses. But this objection applies only to the careless, and may be predicated of many other remedies in common use. We must take the world, however, as it is, and not as it should be; and when, therefore, as in the case before us, a choice exists, let us banish the evil as far as the choice extends. It should still, however, be recollected that, in the case of the bark, a morbific virtue may be in operation in the therapeutical doses of that agent, while the same special virtue does not appertain to arsenic (§ 150, 847 *g*, 848, 859, 863 *d*).

It appears, therefore, that arsenic will be wanted mostly in neglected or badly-treated cases of intermittent fever; and the former will be more likely to yield to other means than the latter. In the neglected cases, disease can, at most, have been aggravated only by errors on the part of the patient, while art, with its powerful morbific agents, may lay the foundation of very intractable local maladies that shall impart great obstinacy to the constitutional disease, as unintermitting exciting causes (§ 659, *b*). Cases undoubtedly arise, also, at certain seasons of the year, such as the autumnal (§ 892¼ *c*), to which arsenic is better adapted than quinine, or where the latter may fail on account of its tonic virtue. Again, other cases sometimes present themselves at all seasons where the vegetable remedy fails under the most judicious treatment. This may be owing to very peculiar modifications of the pathological states, or to unusual affections of certain parts, or to some idiosyncrasy. In short, arsenic is the next remedy, appertaining to the group before us, which should be tried after the failure of cinchona. But, it by no means follows that agents from other groups may not be equally or more appropriate. It happens, frequently, in prolonged or badly-treated cases of intermittent fever, where the liver or spleen become the seat of enlargements and indurations, that iodine may be employed very successfully in conjunction with quinine. The accession of these two agents to the Materia Medica has contributed, largely, in this as in other respects, to the facilities of art.

It has placed, indeed, the foregoing affections greatly under the control of either; and, what is very important, where the bark was inadmissible during the coexistence of fever with the chronic derangements, quinine is often adapted to both conditions; so only, the treatment be properly conducted in its other details. Iodine, however, is only appropriate after an ascendency is obtained by other remedies over the febrile state, and where the force of the local affections exists in that subdued form which inflicts no exciting sympathies upon the organs of circulation. Otherwise, that intensity should be first moderated by leeching, blistering, low diet, &c. With this qualification, and in the absence of fever, iodine has contributed not a little toward the exclusion of arsenic from the treatment of agues.

In some of the conditions of which I have just spoken, arsenic is advantageously associated with quinia, or administered in the associated form of a salt.

892¼, *e*. We finally come to the conclusion that arsenic ranks next to cinchona in the certainty with which it overcomes intermittent fever. But, it is less certain, and less rapid in effect; and the objection which applies to it as an energetic poison in over-doses should hold it in reserve, to be employed only where cinchona, or quinine, properly administered, may fail. Such as may study disease in its philosophical aspects, taking a comprehensive survey of its varied pathological conditions, firmly resisting the prejudices which timidity or ignorance have heaped upon bloodletting, and who prescribe for the absolute conditions rather than for the name of a disease, will rarely find it necessary to have recourse to arsenic in the ordinary forms of intermittent fever.

892¼, *f*. It is not improbable, however, that this agent may be found more useful in the distinctly intermitting inflammations which accompany marsh fever. It is always difficult to adapt even a cinchona alkaloid to these inflammatory states, while it never fails to exasperate the inflammation, if administered before a strong impression has been made by bloodletting and other antiphlogistics.

892¼, *g*. Intermitting headache is a more common form of periodical disease than inflammation, in which arsenic proves often useful, and frequently where cinchona has failed. And so, also, of periodic tic douloureux.

892¼, *h*. Besides the intermitting affections, there are others to which arsenic is well adapted, and which strikingly illustrate the profoundly alterative and comprehensive remedial virtues of this agent. These remaining conditions of disease are so evidently different from the intermitting, that I have reproduced the arsenical preparations in two other groups of remedies, in my Materia Medica. It is important, in the first place, to regard each remedial agent of two or more virtues as a whole, and to consider its operation under its compound aspect. But, in this state of complexity they cannot be brought into that practical use which is promoted by the method which I have projected of considering the various properties of remedies in an individual sense, and according to the prominent conditions of disease to which they are suited, and by associating under the several denominations of disease the various remedies adapted to them, and in the relative order of their therapeutical value, and, therefore, presenting under each denomination groups of remedies having certain remedial virtues analogous to each other, however they differ in other properties, or however different may be the special influences by which the various agents under any given denomination of disease establish those changes which give to Nature the recuperative start. In this manner, a single compound remedy comes to be distributed into what is equivalent to several agents; each remedial adaptation to possess an individuality which distinguishes it from other remedial virtues that qualify the agent as a remedy for other morbid conditions. In this way, I say, we avoid a confusion which has prevailed so extensively from considering a remedy of compound virtues in its general aspect alone. We are led to an attentive examination of its severa virtues, of their critical relations to different pathological conditions . . . his

to acquire a more distinct apprehension of the properties of life, of the modus operandi of remedial agents, and of the laws which govern the organic being under all his conditions of health and disease.

892¼, *i.* The diseases which fall, more or less, under the power of arsenic, and which illustrate the extent of its remedial virtues beyond those which have been hitherto considered, consist of certain chronic eruptive affections of the skin, cancer, noli-me-tangere, chronic rheumatism, diseases of the bones, syphilis, elephantiasis, &c. In some of these conditions, especially in cancer, it is applied internally as well as externally. Iodine has been also advantageously associated with arsenic in the treatment of some of these affections.

Of the foregoing diseases, those of the skin, lepra especially, are the cases in which arsenic is most efficient, and but for the discovery of iodine, would give to arsenic an invaluable rank as an alterative agent for many of these chronic conditions.

IODINE.

892½, *a.* Considering the extensive and powerful nature of the alterative effects of iodine, it is remarkable that in its small therapeutical doses it produces no well-marked effects upon the function of any organ in its healthy state. In this respect, therefore, it goes with arsenic, and the rest, in illustrating the nature of life, and in enforcing a limitation of inquiries into the therapeutical capabilities of remedial agents to morbid states of the body (§ 137 *d*, 150, 854 *bb*, 870 *aa*, 892¼ *b*). When its use is long continued, emaciation is said to have sometimes followed, and now and then a low state of gastro-enteritis has been supposed to have supervened when iodine has been employed in large doses. This, however, is considered a rare effect, and to depend upon the incautious use of the medicine. It has doubtless happened in morbidly irritable states of the alimentary canal (§ 137 *d*, 150). Lugol, who had great experience with iodine, says, that so far from even occasioning a wasting of the body, it promotes growth, and increases the size of organs, in their healthy state. The nervous system is said, also, to have been occasionally disturbed, in natural states of the body, by therapeutical doses of iodine; attended by headache, giddiness, &c. But here, too, there had probably been an antecedent derangement of the alimentary canal, &c. It has been also laid to iodine, that it has occasioned a state of the system which merits a name significant of one of its morbific propensities; and hence that of *iodism* has been associated with the remedy. This condition is marked by vomiting, purging, cramps, emaciation, fever, &c. But, I am apt to think that the fault, in these cases, is chargeable to malad ministration. Others have affirmed that iodine has occasioned salivation; but this, also, is denied by others. In any event, such a result is extremely rare. Twelve grains, on an average, have been given daily for eighty days, making 960 grains, without any manifest effect. In excessive doses, however, iodine is capable of acting as an irritant poison; or, should disease be present, the whole aspect of the subject is changed. I have never witnessed any of its alleged effects upon the healthy system.

A remedy, therefore, so exempt from all untoward effects upon the healthy body, and, withal, as inoffensive in the hands of the tolerably skilful, yet capable of a vast range of the most important reme-

dial effects, must be regarded as an accession to the Materia Medica of great value.

892½, *b*. I have been thus led to consider the effects of iodine upon the body in a state of health, in its ordinary doses, for the purpose of contrasting them with some of the remarkable therapeutical influences of which iodine is capable, and to show how the vital states are changed in their relation to remedial agents by morbid states. This, however, may be equally instituted with many other very powerful remedies, even those which are liable to act upon morbid states, in their therapeutical doses, with the intensity of energetic poisons, or striking at other alarming maladies, yet manifest no sensible effects upon the healthy organism (§ 137 *d*, 150, 870 *aa*).

892½, *c*. Perhaps the most remarkable demonstration of which iodine is capable is in those latent forms of disease where nothing is present to denote the morbid state but some gradual change of organization. This is seen especially in bronchocele, for which affection it surpasses, greatly, any other remedy. And here it may be said, as indicative, in every aspect of the subject, of the vital philosophy of the operation of iodine, that it is often as efficient in most of the local forms of disease for which it is employed, whether it be administered internally, or applied externally. It is also an important fact, of the same import, that the external application must be made over the region of the affected part, when disease is seated internally; in which respect its mode of action through its own special virtues borrows light from the modus operandi of counter-irritants. Its control over the ordinary form of bronchocele is thoroughly established, and where it has failed I have no doubt it has been generally owing to some defect in the treatment.

I say, the common form of bronchocele; for there are some conditions of the thyroid gland which nothing will reach; which is one of the endless exemplifications of the importance of addressing our remedies to the exact pathological condition. Now the true bronchocele is constituted by a low indolent action of an inflammatory nature, that which results in hypertrophy; better known at present as a "lesion of nutrition." But iodine will not touch such lesions; and, although it seek out the obstinate forms of disorganization, there are some morbid changes of the thyroid gland which have been mistaken for bronchocele, and where iodine has disappointed expectation, and has suffered the blame of another's fault. Among these intractable conditions are formations in the gland of other substances than deposits of lymph, such as stony and other concretions. Or, again, the organ takes on a scirrous condition. Or, at other times, it enlarges suddenly, and shows high vascular action, which ends in an effusion of serum; the gland becoming enlarged in consequence. But this condition is not apt to remain long; and, although it subside spontaneously, it is not amenable to iodine. The remedies consist of leeches, vesicants, &c.; and, if such treatment be applied to the indurated states of bronchocele, preliminary to the use of iodine, this remedy will not often fail of accomplishing the residue of the cure. It is also indispensable to subdue, in the first place, any attendant excitement of the general circulation, or functional derangement of the chylopoetic viscera. These, indeed, are important objects of attention, whatever be the nature of the disease for which iodine may be prescribed. The

external use of iodine, in the treatment of goître, is not less efficient than the internal; so that both methods may be associated. Or, where objections apply to the more constitutional mode, the local application is often admissible. But iodine will not, like the mercurials, extend its influence over the system through the medium of the skin. Its effect is then by contiguous sympathy alone (§ 497).

892½, *d.* Soon after the discovery of iodine, Dr. Coindet applied it successfully to the cure of scrofula. His observations were soon followed up by others; so that the claims of the remedy became early established in respect to this most intractable disease. Numerous cases and memoirs were published, all tending to advance inquiry into the new and extraordinary agent; extraordinary as well in its relations to the inorganic as the organic world. It was early and successfully tried upon an extensive scale by Dr. Manson, in various conditions of scrofula, scrofulous ophthalmia, &c.; employed both internally and externally. Then followed Lugol, attached to the hospital of St. Louis, who published three memoirs confirming the favorable report of his predecessors. This narrative is always due to the early founders of a remedy which has already bestowed incalculable blessings upon man; not short even of cinchona, since we had in arsenic, and numerous other means, pretty good substitutes for that. And now, when we pause for a moment over the countless numbers who have been already rescued from the grave by iodine alone, and when we attempt to think of the labyrinth of medical philosophy through which the enlightened physician directs, with so much relief to the whole race of man, the most potent, as well as the milder agents, of the Materia Medica,—ay, the *remedium principale* itself, what shall be said of that credulity of the public which reposes its confidence in the charlatan, or yields the Pæan triumph to an Apollo in surgery?

Lugol's authority is valuable. His experience has scarcely been improved. He employed the remedy internally and externally, and treated the various conditions to which scrofula is liable, from the simple glandular swelling, ulceration, abscess, &c., to its destructive effects upon the cartilages and bones. An exception, however, must, and probably always will, be made in respect to tuberculous phthisis. He prefers a solution of iodine with the iodide of potassium, in water. This he administered either in the form of drops, or largely diluted with water under the denomination of ioduretted mineral water. It has become, indeed, a standing formula; but to which there is the same objection as applies to all other analogous prescriptions. They all require variations in the relative proportions of their constituent parts, and lead to a neglect of the varying pathological states of a common form of disease (§ 150, 672, 673, 857, &c.). It is doubtful, however, whether the union of the iodide of potassium often increases the efficacy of the simple iodine; although the salt, being less energetic, is often better adapted to irritable states of the alimentary canal, or where the circulatory organs are liable to excitement. It is readily seen, therefore, that for this reason the iodide of potassium may be often united in variable proportions to the more active and irritating form of the remedy.

892½, *e.* It should be considered, however, in reviewing the favorable reports which have been made of a new remedy, that here, as in most other cases, other observers have been less successful with iodine;

though a general admission obtains that it is more useful in scrofulous affections, with the exception of phthisis, than any other agent. This, therefore, is sufficient to place it upon very high ground as it respects the most Protæan disease. There is much reason to think, however, that those who have been least successful have often failed from not having bestowed the same attention upon those general means of improving health, such as diet, warm clothing, exercise, &c., which are, of themselves, not unfrequently curative of scrofulous affections; as they are of syphilitic. When remedies are employed in any given disease for the cure of which they have acquired the reputation of specifics, we are often apt to rely too exclusively upon the supposed specific, and the remedy, in consequence, frequently fails when it would have succeeded under a proper regard for the subordinate means. Failure in this respect may turn the "specific" into a formidable foe, especially in active forms of disease (§ 137 *d*, 150, &c.).

Again, since the early day, recent to be sure, of the wonder-working power of iodine, the reputed pathology of scrofula has undergone a revolution; and where abstraction of blood, general or local, a non-stimulating diet, &c., were often considered necessary, especially in the primary stages of phthisis pulmonalis, a tonic and stimulant treatment has been erected upon the new doctrine (§ 4, 5¼. Also, *Med. and Phys. Comm.*, vol. ii., p. 608–634, 743–746, 780–782). From my own observation, I can entertain no doubt that iodine is yet destined to yield an important aid in the treatment of tuberculous phthisis; while it will rarely fail to aggravate the disease if employed before inflammation is brought under the discipline of the lancet, low diet, &c., or where the alimentary canal, or the system at large, is in an irritable state.

892½, *f*. Thirdly. The power of iodine, and of its combinations, reaches yet farther, and more remarkably, perhaps, than as respects its control over bronchocele. It has often accomplished the removal of certain chronic affections which appeared to have been removed from the reach of every other medical agent. This has been especially true of many cases of those affections which have run on to induration. Here it is that iodine illustrates its remarkable virtues as an alterative, in breaking up the most obstinate conditions of disease, changing entirely the long-established morbid action of those capillaries from which the deposition of a peculiarly modified condition of lymph arises, and which forms some of the worst enlargements and indurations short of carcinoma (§ 733 *f*, 738, 740 *a*, *b*); while, also, its sanative effect must extend to the absorbent system of the part, increasing its energy, and thus reducing the volume of the organ and restoring it to its natural state. Mercury, it is true, will accomplish this in some instances, but is comparatively inoperative, and they are beyond the reach of quinine.

Coming to those chronic enlargements and indurations of the liver and spleen, which form the sequelæ of intermittent and remittent fevers, the Peruvian alterative finds a competitor in iodine, though they will now harmonize together (§ 892, *kk*). Mercury, too, in some of its forms, is also more or less applicable to these conditions. But, to iodine we look with greater confidence in the intractable shapes; and here we may not calculate much upon the cinchona alkaloids. Nevertheless, even here mercury may be often advantageously asso-

ciated with iodine; and this is particularly true of bad forms of hepatic induration. Iodine, however, is more apt to take, in its therapeutical scope, those enlargements of the spleen which are known as ague cakes. They have often yielded to its influence in this and in other countries; and sometimes, indeed, where the splenic induration has been independent of fever, and where quinia is powerless (§ 662 *a*, 813 *b*, 814, 816 *b*, 892 *kk*).

The uterus, in its former intractable indurations and enlargements, has frequently yielded of late to the alterative action of iodine. Even when of a bony hardness, and filling nearly the cavity of the pelvis, this condition of the uterus has given way to iodine in the space of six weeks, the volume of the organ reduced to the natural size, and the catamenia restored. Here the dependence was upon iodine alone; and justly so, since there was no local or constitutional inflammatory symptom to require the co-operation of a depletory treatment. But, in other examples, where more or less active inflammation has attended the uterine enlargements, local and general bloodletting, rest, low diet, &c., have been brought advantageously to the successful use of iodine (§ 855, 856). It is astonishing, too, with what rapidity these conditions of the uterus have given way; yielding entirely, in the most successful cases, within periods varying from six weeks to four months.

These uterine cases, like the ophthalmic, illustrate the safety and advantage of applying iodine directly to the affected part, wherever accessible; it being rubbed, in the form of an ointment, in the case of the uterus, upon the neck of that organ. This practice has succeeded especially where the neck of the uterus has been the special seat of induration, and of those hard tumors which are liable to run into ulceration.

Iodine has even made salutary impressions upon ovarian tumors; and here, too, it is mainly useful in the indurated enlargements of the ovaries, and probably little, if at all, in ovarian dropsy.

Leaving the uterine system for its associate mammary gland, we have many accounts of its partial success, at least, in those scirrous affections which put on some of the aspects of cancer, but without its malignancy; relieving the distress, and holding the disease in check; while even cancer itself, and in its ulcerated state, is said to have derived mitigation from the external use of iodine.

Few affections are more sad than enlargements and indurations of the prostate gland; and here, too, the sufferer has sometimes obtained relief from this remarkable agent, both from its internal and external use.

The parotid glands swell up and remain permanently enlarged and indurated after scarlatina, and from other transient causes; and the lymphatic glands become involved in the same way from sympathy with diseased states of the stomach, or from other causes not connected with the scrofulous diathesis. In all these cases, iodine is the most efficient agent; at least, in a general sense. But these are cases, also, for leeching; which not only greatly helps the restorative change, but imparts, also, greater efficacy to the iodine. Indeed, it is not unusual that repeated applications of leeches to these glandular tumors, although of an extremely indolent nature, will alone overthrow their morbid states, and disperse the whole affection. It is a common mode of treatment in my practice, and has often revealed an alterative influence of the remedy of which cupping is incapable.

892½, *g*. Iodine has been employed internally and externally, with various degrees of advantage, in chronic affections of the skin, such as lepra, icthiosis, psoriasis, &c., and it has been applied in the same way to arrest the progress of phagedenic and other destructive ulcers, which often put on favorable changes under the local as well as constitutional effects of this agent.

892½, *h*. Nor has secondary syphilis refused to yield to the power of iodine; and this, too, in cases where mercury has either failed, or has aggravated the affection. But, these cases are not common, and we should not be led away from the better remedy by rare examples of greater success from an agent which will commonly fail. Where iodine has succeeded in cases of this nature, without the co-operation of mercury, the syphilitic affection was probably under the influence of the scrofulous diathesis (§ 659, 662 *a*). Besides the internal proof concerned in these cases, the foregoing conclusion is strengthened by the emaciation, ulcerations of the skin and throat, and the inflammation of the bones and periosteum, which attend the cases where iodine has exerted an independent sway.

But iodine has succeeded most happily in syphilitic cases when combined with mercury; especially where syphilis has affected scrofulous subjects. But simple iodine, true to its great prerogative of overthrowing deep-seated mischief of chronic glandular inflammations, has been successfully applied to old venereal affections of the testicles, and to indolent buboes.

892½, *i*. Gonorrhœa and leucorrhœa, in their indolent states, have been successfully treated by iodine; especially so in scrofulous habits, when the relief it yields is more uniform than in other cases.

892½, *k*. I stated just now, that iodine has been more successful in real ovarian tumors than in simple ovarian dropsy; but other dropsical affections have not escaped the far-reaching virtues of this new agent; though I have not much to say in commendation of its efficacy on this score. As in many other affections, it is evident that iodine delights in the worst forms of dropsy, and is little disposed to grapple with those simple conditions which depend upon mere inflammation of the serous or cellular tissues. It makes its attack, rather, upon those dropsies which nothing else will reach; such as are symptomatic of organic affections of the liver, or kidneys, or spleen, or heart, &c., and where a low inflammation is instituted, sympathetically, in the serous tissue of the abdomen or thorax, as the immediate proximate cause, and kept up by the organic disease. And now we understand how it is that iodine will sometimes reach these most formidable dropsies, since it is the peculiar province of this agent to break up old organic lesions; and, in exerting this astonishing office in regard to the liver, &c., the cause which maintains the serous inflammation is removed, and the dropsical affection disappears as a consequence. Hence, again and again, the importance of looking well not only to the nature of the pathological cause, but to all the complications with which it may be attended, and their sympathetic relations to each other (§ 905).

892½, *l*. Iodine has been successfully employed as an emmenagogue by most of the physicians who have illustrated its uses. My own observation leads me to believe that it is mostly useful in restoring menstruation in subjects of a scrofulous diathesis; and here it will be sal-

utary, if not contra-indicated by irritable states of the stomach and intestines. But, even in such cases, the iodide of starch, or the milder sponge, may be admissible; and this remark, it will be readily seen, is more or less applicable to other affections attended by morbid irritability of the gastro-intestinal mucous tissue.

The same agent is also entitled to much consideration as an indirect emmenagogue in all cases where suspended menstruation is complicated with chronic enlargements or indurations of any of the great internal viscera. In these instances, the uterine affection is only symptomatic of graver disease, as, indeed, it may be said, in a majority of other cases, to depend upon a primary though only simple derangement of some other part, especially of the alimentary canal (§ 689 *l*, 905).

892½, *m*. Chronic rheumatism has proved itself amenable, in some cases, to iodine. We shall find, however, much better remedies for rheumatism, in all its aspects. But, it is not remarkable, that a power so sovereign in many other intractable maladies should sometimes succeed in whatever less difficult and somewhat analogous instances it may be brought to bear. It must be considered, also, that the scrofulous diathesis is common, and that here iodine is at home.

892½, *n*. In the form of iodine vapor, the novelty is even held up as a remedy for pulmonary consumption by Sir C. Scudamore, Sir James Murray, and others. But, it is scarcely probable that this condition can be effected in any other way than through the constitutional method, and it may be expected that the vapor will share the fate of boiling tar, and the steam of the horse-stable.

892½, *o*. Gout has yielded to this potent but quiet remedy. The swellings of the joints have given way, not only in chronic, but in some acute forms of the disease. Those practitioners who have employed it in the latter case are probably of those who cure the same disease with bark and wine, and it has been overrated in the former. With the same experimental views, iodine has been administered in diabetes mellitus; but, whether it may be useful or detrimental in this disease will depend, clearly, upon the circumstances of each individual case; especially upon the state of the digestive organs, which take an important part in the pathology of diabetes.

892½, *p*. Iodine is employed by the surgeon for various local purposes, among which many forms of ill-conditioned ulcers are the most common. Here it often manifests its sanative influence, but more so when the cases justify its internal use. It were well, too, if these cases were oftener treated according to the precepts of medical philosophy and the experience of sound physicians.

892½, *q*. The ioduretted bath has been overrated, but, perhaps, is unwisely falling into disuse.

The details as to dose, &c., must be sought by the young inquirer in the appropriate books. There, too, he will find some useful combinations of this with other substances, which have been brought together by the chemist, who is always laying the profession under these high obligations. We shall not often want, however, more than the simple substance, the iodide of potassium, the iodide of mercury, and the iodide of starch. It is not improbable, also, that we may sometimes find in bromine, or some of its combinations, useful substitutes for iodine.

892½, *r*. I have spoken of the iodide of starch as suitable in many cases where the intestinal canal, or the system at large, is too irritable for the more active forms of iodine. But, I am apt to think that, in such cases, we may also fall back advantageously upon the vegetable æthiops, or upon the burnt sponge. They have done us service in former times, and may do it again.

It is certainly a curious fact, in the history of the Materia Medica, that the fucus vesiculosus and the sponge, one an unseemly weed of the ocean, and the other an anomalous organic being from the bottom of the Mediterranean, should have been applied to the relief of bronchocele and scrofula, and have led to the important supplement which the Materia Medica has enjoyed in the iodides and bromides. Nor is it less curious, that a remedy for the same affections had been detected in the liver of the cod.

Although the day of these mysterious agents has passed away,—passed in their uses and their mystery,—it may be that exigencies may now and then commend to our notice their quiet influences; when we may depend upon it, we shall find organic nature as undeviating in these low conditions of life as in all other objects within its comprehensive range. We shall always find iodine and bromine among these humble tenants of the deep; and, in doses of one drachm to four of the calcined preparations, we may depend upon results, if not as certain and speedy as those of iodine or bromine, at least such as will evince an efficient remedial power (§ 290, 350, nos. 25, 26, 26½, 28).

892½, *s*. It sometimes happens when iodine, or its compounds, irritate the intestinal canal, or the system at large, they may be rendered compatible by small quantities of morphia, or the extract of hyoscyamus, or of lettuce, &c. This interposition of narcotics, however, to promote the tolerance of iodine, demands great care; and the narcotic must not be detrimental if the iodine were not employed. But, it commonly happens, when iodine produces its salutary effects, that it improves the appetite, if it have been deficient; or, at least, does not impair it. In a general sense, also, if the subject have been thin, he gains in flesh under its influence. These affirmations can be made of no other remedy, excepting bromine, of equal curative power. It is often, indeed, upon the digestive organs that the first salutary effects of iodine are manifested; as seen not only in the improvement of appetite and digestion, but in the more abundant elaboration of bile, and in a healthier aspect of the fecal discharges. Simultaneously, also, the bowels act more freely; and, when purging takes place during the use of iodine, it is probably often more from the redundant flow of bile which it has promoted, than from the direct action of the remedy upon the intestinal canal.

892½, *t*. Here, then, through these effects upon the organs of digestion, we arrive at an interpretation of those salutary changes which are exerted upon parts remotely situated. It is either a direct sympathetic result, or the sympathetic consequence of the removal of disease from the abdominal viscera, by which the remote affections had been maintained (§ 803, 804, 905).

892½, *u*. In a general sense, it has been found that a non-stimulant diet promotes the salutary effects of iodine. This agent is, in itself, a stimulant to the circulation in most of the morbid states to which it is

applicable; and, while it heals by other virtues, its stimulant properties disqualify it for all active conditions of inflammation (§ 137 *d*, 143 *c*, 150, 151). It is therefore an object in the lower forms of inflammation which come within the range of iodine, to avoid increasing the susceptibility to its stimulant virtues by stimulating food (§ 143 *c*, 556 *c*, 872 *a*). In such conditions, indeed, abstemiousness, in respect to food, is in itself directly curative (§ 150, 856, 863, 1007 *b–d*, 1008).

But, there are some conditions to which iodine is peculiarly suited, particularly bronchocele, when the general health is often sound, and when the ordinary diet may be pursued (§ 143 *c*, 150, 151, 892½ *a*). In most other affections to which iodine is adapted, the general health is apt to be unsound, and the local affections of a distinctly inflammatory nature.

892½, *v*. That iodine should sometimes fail of removing, or even of mitigating the diseases to which it is most appropriate, is certainly to be expected. This want of uniformity may be affirmed not only of all known remedies, but of such as are unknown. It results necessarily even from the different natural modifications of the vital states of different individuals. The principle is shown under various aspects in former sections (§ 585). But, it may be safely said, that the remedial power of iodine in numerous forms of disease that had baffled the most enlightened efforts, is fully established.

ERGOT.

892⅔, *a*. The origin and organic character of ergot have been only recently well determined. Many have supposed it to be a morbid conversion of the seed, produced by some insect. Others regard it as a parasitical fungus; and it is incorporated by them as a true plant in the genus selerotium. It has been shown, however, by Tessier, and others, that a part only of the grain sometimes becomes ergotized; which proves sufficiently that it is not a fungus. The stigma, too, often remains at the top, and the ergot, like the rye, is intimately connected with the receptacle. Other observations, more recently made, prove conclusively that the microscope has been at fault, even in this very visible and hard substance, in its report of parasitical fungi as constituting the ergotized rye (§ 83 *b*, 131). The ergot is now sufficiently shown to be a morbid degeneration of the rye.

892⅔, *b*. Ergot was introduced into regular practice, as a powerful agent for exciting uterine contractions during the process of labor, by the venerable JOHN STEARNS, M.D., of the city of New York, in a letter to Dr. Ackerly, in 1808; though it had been a popular means of expediting labor a century and a half ago, in Germany, Italy, and France.

This letter of Dr. Stearns has not often met the public eye, nor has that reward attended the service which it was the delight of darker ages to bestow upon the great benefactors of man. The letter, too, is interesting from the brevity with which it announces a most important discovery (new at least to the profession), for the perfect accuracy with which the effects are described, and for the precautions which Dr. Stearns had the sagacity to suggest as to the circumstances under which this agent should be administered, but which have been most strangely violated by others.

The brief statement, which has now grown into volumes, of the wonderful properties of ergot, and of the only known substance which is capable of exciting uterine contractions, contrasts in its brevity and modesty not less remarkably with the never-ending and inflated accounts which are often coming to us of worthless specifics, and more worthless speculations, than does the gigantic power of ergot form an imposing contrast with the whole host of those pretended remedies which have fallen into oblivion, one after another, when their inefficiency has been proved by an adequate sacrifice of human life.

But let us once more call into light the original announcement. Thus the letter:

"In compliance with your request, I herewith transmit to you a sample of the *pulvis parturiens*, which I have been in the habit of using for several years with the most complete success. It expedites lingering parturition, and saves to the accoucheur a considerable portion of time, without producing any bad effect on the patient.

"The cases in which I have generally found this powder to be useful, are when the pains are lingering, or have wholly subsided, or are in any way incompetent to exclude the fœtus. Previous to its exhibition, it is of the utmost consequence to ascertain the presentation, and whether any preternatural obstruction prevent the delivery; as the violent and almost incessant action which it induces in the uterus precludes the possibility of turning. The pains induced by it are peculiarly forcing, though not accompanied by that distress and agony, of which the patients frequently complain when the action is much less. My method of administering it is either in decoction or powder. Boil half a drachm of the powder in half a pint of water; and give one third every twenty minutes till the pains commence. In powder I give from five to ten grains. Some patients require larger doses, though I have generally found these sufficient.

"If the dose be larger, it will generally produce nausea and vomiting. In most cases you will be surprised with the suddenness of its operation. It is, therefore, necessary to be completely ready before you begin the medicine, as the urgency of the pains will allow you but a short time afterward. Other physicians who have administered it concur with me in the success of its operation.

"The *modus operandi* I feel incompetent to explain. At the same time that it augments the action of the uterus, it appears to relax the rigidity of the contracted muscular fibres.

"It is a vegetable, and appears to be a *spurious growth* of rye. On examining a granary where rye is stored, you will be able to procure a sufficient quantity among the grain. Rye which grows in low, wet, ground yields it in greatest abundance. I have no objection to your giving this any publicity you may think proper."—John Stearns, in *New York Medical Repository*, vol. xi., p. 308, 1808.

That is the whole; correct in every aspect, and without a practical improvement from that day to the present; unless it be an extension of some of the minor points which are embraced in the comprehensive statement of the discoverer. It may, therefore, stand as an admirable concentration of all the leading details relative to this great accession to the universal cause of humanity and medical science. It is the best general guide for the practitioner that can be devised, and had it been duly posted in medical journals and obstetrical works, in-

stead of some of its violations which have appeared from time to time, it will be conceded, I cannot doubt, that I am not astray from the objects of the present work in bestowing an ample notice of the origin of an important remedy which stands alone in the natural world.

No sooner was this discovery announced, than its value was proclaimed in different quarters, not only by a confirmation of the imputed virtues of ergot, but by an opposition to its use on account of those very attributes of the remedy. It was said to be dangerously violent in its uterine influences. And so it is, like all things else in their various relations to disease, unless employed with a proper reference to "precaution" (§ 137 *d*, 143 *c*, 150, 151).

With others, there was not a ready disposition to concede the merit of originality, and records were hunted up for the purpose of showing that ergot had been long before in the hands of the common people, about in the same way as had been the cow-pox before Jenner confirmed its protective power. But, whether the former was of any greater use than motherwort, the profession had not troubled themselves to inquire.

Frightful accounts were also quoted of wide-spread and fatal epidemics, which the superstitious had charged upon rye, of which ergot was supposed to be the insidious cause (§ 892¾, *l*). A more feeble conjecture was never assigned for epidemics; unless the hypothesis be excepted, that damaged rice was the cause of the malignant cholera in Asia and Europe, because the patients had "rice-water evacuations;" and, also, that the milk of cows in some of our Western States is the cause of a malignant form of miasmatic fever (*Med. and Physiolog. Comm.*, vol. i., p. 537–539).

Other writers entered the field against the new agent, in other shapes; some of them denouncing the remedy as invariably fatal to mother and child, while others affirmed that it was as inert as rye itself.

But time puts all things right, though it may come too late for him who should reap the reward. Harvey lost all his practice because of the envy which was excited by his discovery of the circulation of the blood; and nothing but demonstration upon demonstration to the eyes of the multitude rescued Jenner from the execration which he received because he had been so unfortunate as to render a great service to his cotemporaries. Newton, too, was so annoyed by opposition that he regretted his pursuits, and has left, in consequence, his stamp upon the very front of Philosophy, that she is "a capricious maid." And who among philosophers does not know that at this moment a part of their corps are disputing with the amiable and unresisting Draper his great discoveries relative to the light of the sun (§ 188½, *d*)?

It was not so in the early ages of our art; and had Harvey, or Jenner, or Stearns, have lived at that remote period, temples would have overspread the land for the perpetuation of their names, and as grateful memorials for their services to the universal family of mankind.

892⅔, *c*. Ergot is poisonous to flies, leeches, and some other small animals. In very large quantities it is said to be destructive to dogs, cats, pigs, sheep, rabbits, fowls, &c. But this effect has been evidently overrated, since it appears that some ounces were necessary to affect rabbits and pigeons. Sheep are put down by Pereira, in his

Materia Medica, among the animals that are liable to be poisoned by ergot. But a little farther on he says that, "In 1811, twenty sheep ate together nine pounds of it daily for four weeks, without any ill effects. In another instance, twenty sheep consumed thirteen pounds and a half daily, for two months, without injury." And then as to other animals: "Thirty cows took together twenty-seven pounds daily, for three months, with impunity; and two fat cows took in addition nine pounds of ergot daily," with no ill effect whatever.

The same conflicting statements are made as to the effects of ergot on man in health; some affirming that in doses of half a drachm to two drachms, it excites nausea, occasions pain in the head, dilated pupils, &c.; while other experimenters declare that it produces no effects whatever. This is probably the fact; since we have heard of only some very rare cases in which it has had any other effect upon the susceptible pregnant, or parturient female, than that of exciting uterine contractions. We may, therefore, conclude that the fractional number of some five or six cases in which delirium or stupor are said to have resulted from doses of half a drachm to two drachms were due to other causes; especially when it is considered that such affections of the head are not unusual with parturient women where no ergot has been exhibited.

Universal and large experience has settled the fact that ergot has no special influence on the nervous system, and that, in its therapeutical doses, at least, it is perfectly inoffensive when administered with the proper "precautions" that are relative to the uterine system. This consideration, therefore, imparts an inestimable value to the uterine agent; and the other attending circumstances go with iodine, arsenic, &c., in reprobating all conclusions as to the therapeutical virtues of any agent which are associated, as inductions, with its manifestations upon man in health, and especially upon the modified constitution of animals, or the yet greater modifications that are presented by vegetable life. There is, indeed, nothing in nature possessing virtues analogous to those of ergot, while, also, its only manifest influences are pronounced under special modified states of the uterus. But, perhaps you say, and truly, too, that other things will excite abortion, or sometimes hasten natural labor. But, in all such cases, the results depend on very different influences; on some violence inflicted on other parts, or some uterine or other malady which may be thus removed. Cantharides may have sometimes excited abortion; but, if this be true, it is practically useless, rare in the effect, and obnoxious to other palpable objections. The highest practical as well as philosophical considerations are every where involved in the principles now, again, under investigation (§ 137 *d*, 143 *c*, 150, 151, 650, 831, 836, 854 *bb*, 857, 859 *b*, 892 *c*, 892½ *b*, &c.).

892⅔, *d*. The next question which comes up relates to the circumstances under which the uterus is susceptible of the influences of this specific agent; for this *one* may be so regarded till others may appear which will accomplish the same results.

Such is the remarkable action of ergot after labor has been instituted, especially after the usual period of gestation, that it was natural, perhaps, to suppose that the agent can bring on the process by its own specific virtues (§ 143 *c*, 150, 151, 652 *c*, 863 *a*). Experiments have been accordingly made upon animals to ascertain whether abortion would be thus brought about; but Villeneuve, Warner, Chatard, and

others, have failed in all their attempts, whether the ergot be injected into the circulation, or administered by the stomach (§ 150, 151). But this would not prove that abortion may not be thus instituted in the human subject (§ 892⅔, *c*). And to show how deeply founded in nature are some of the important laws embraced in a former section (§ 150), it is worthy of remark that ergot commonly promotes the uterine contractions in dogs, cats, sheep, cows, deer, and, indeed, of all other animals, so far as tried, after natural labor has been for some time in progress; even where the uterus has become exhausted by its long-continued efforts.

As to the human female, there is probably not much doubt that ergot is capable of exciting abortion. Its vital relations, in the pregnant state, are more or less in correspondence with the virtues of the agent (§ 143 *c*, 150, 189 *b*, 892⅔ *c*). The question is stated in the following manner by an adequate observer, and who believes in this remarkable virtue of the great uterine agent:

"Given," he says, "to excite abortion, or premature labor, ergot has sometimes failed to produce the desired effect. Hence many experienced accoucheurs have concluded that, for this medicine to have any effect on the uterus, it was necessary that the process of labor should have actually commenced. But, while we admit that it sometimes fails, we have abundant evidence to prove that it frequently succeeds." Other able observers testify to this fact; Müller, Ramsbotham, and other familiar names.

It is evident, too, that ergot is capable of acting upon the uterus, and of exciting contractions of the organ, in its unimpregnated state, when its susceptibilities are increased by disease (§ 143 *c*, 150, 151, 177, 189 *b*). Uterine polypi have been thus expelled, and menorrhagia arrested.

But, this ceases to be remarkable, when it is considered how greatly changed is uterine irritability in a state of pregnancy; when the most trifling causes, such as lifting a chair, putting up window-curtains, sudden joy, sudden surprise, or grief, will rouse the muscular action of the impregnated uterus, and bring on abortion (§ 150, 151, 189 *b*, 227, 233, 233¾, 904 *d*). If we now add to the foregoing considerations the increasing tendency to abortion in proportion to the frequency of its occurrence, it may aid our philosophy of life in its general aspects, and concur with other facts in a specific illustration of what I have propounded as to the laws of *vital habit* (§ 535–567).

Our experimental knowledge, however, as to the ability of ergot to institute labor must be always limited; for opportunities must be rare in which a physician of any moral sense, and therefore of any reliable truth, would administer this, or any other agent, with a view to producing abortion. Even in the very limited number of cases where art is called upon for this solemn duty, it rather seeks the mechanical method.

Connected with the difficulty of attaining an adequate knowledge of the power of ergot of inducing abortion (especially the extent of its power), are the numerous mistakes that have been made in respect to other supposed effects of this substance; particularly those which are relative to the epidemics, and which continue to be more or less ascribed to its malign influence. But, what is more to the present purpose, is the important fact, that, although now, as in former times,

there can be no doubt that rye largely compounded with ergot is habitually and very extensively consumed, we have never heard, as one of its evil consequences, that it has given rise to abortion. This undeniable truth, therefore, must settle the question, at least, as to any uniformity in this imputed effect of ergot, and turn our attention to the mechanical means when the interposition of art is required, and our scrutiny to other expedients in detecting the criminality of others. A right decision of the question is one of great interest, not only in a philosophical aspect, but on account of its practical bearings, and, also, in a medico-legal aspect.

892⅔, *e*. It may now be said to the young practitioner, that he should bear in mind that the expulsive efforts are made by the uterus, that all the devices of the lying-in chamber, such as straining, pulling, &c., are worse than useless; that the uterine contractions are increased in violence and frequency soon after the administration of ergot, and that they generally go on increasing till the birth is effected. Indeed, the parturient process sometimes continues, under the influence of the agent, for several minutes after the expulsion of the placenta; but it commonly ceases, so far as the ergot is concerned, after delivery is consummated (§ 150, 151, 652 *c*).

892⅔, *f*. The rapid and energetic action of the uterus led Dr. Stearns to say, that, among other things, it is "of the utmost consequence to ascertain whether any preternatural obstruction prevent the delivery;" and, from what is also said of the circumstances which justify the use of ergot, it is evident that the discoverer considered a full dilatation of the os uteri of indispensable importance to any thing like a safe result. He foresaw that the uterus might otherwise be ruptured, or the external parts lacerated, or the child destroyed by the rapidity with which its head would be forced along the yet rigid parts. He foresaw, I say, a violation of nature if the foregoing condition were not awaited. And how fearfully has this been verified in practice; especially as it regards the fœtus! Why the vast difference in results in the hands of different accoucheurs? Why the numerous cases of cerebral hemorrhage in still-born children, that have come up, of late, for the good of science? The question is readily expounded when we turn to those Essays in which it is affirmed that ergot may be administered when the mouth of the uterus has attained the diameter of half an inch! This has been recommended principally with a view to saving the time of the practitioner; and it opens to us the ground of the prejudices, which have sprung up in enlightened and more honest quarters, against the use of ergot when it can be possibly avoided. Where the safety of the mother does not require earlier interference, it is, doubtless, a good rule not to administer ergot till the head of the child has passed the brim of the pelvis, and the labor has become lingering.

If the remedy be delayed till the os uteri is well dilated, then, by an admirable concert of sympathy, the external parts will have either undergone a corresponding dilatation, or a tendency to an easy dilatation (§ 150, 151, 385, and *references*).

892⅔, *g*. "Previous to the exhibition of ergot," says the discoverer, "it is of the utmost consequence to ascertain the presentation;" and now the only question that arises is relative to the admissible presentations. The os uteri is, of course, supposed to be fully dilated; and it

appears to be conceded that ergot may be employed when the head is turned from its usual position. But, this is not auspicious. Breach presentations admit of its use where labor has become prolonged, and the pains suspended; though here manual aid may be safely applied without the forceps. These instruments are always difficult but in the hand of experience, and are otherwise more or less liable to objection.

892⅔, *h*. It is not alone in protracted labors, where the uterine efforts have ceased to be efficient, that ergot is applicable with a view to promoting delivery. Serious hemorrhages sometimes spring up, where it becomes important to hasten delivery by every possible means that may be less hazardous than the impending evil. In cases of this nature, especially when alarming hemorrhage comes on during natural labor, and the attachment of the placenta be right, we enjoy no means so likely to insure safety and immediate success as offered by ergot; so only the pelvis be not deformed, and the presentation suitable.

892⅔, *i*. So, also, in ordinary cases of abortion, where hemorrhage may become alarming, ergot may be employed to hasten the expulsion of the ovum, and arrest the flow of blood. In these instances, however, the tampon is probably preferable, since it is always sure, and it is not certain that abortion will happen.

892⅔, *k*. Some females are remarkably liable to profuse uterine hemorrhage after natural labor; and these are cases for the administration of ergot a few minutes before the expulsion of the child; whatever may be the activity of the uterine contractions. In such instances it is not unusual for the pains to be quite energetic throughout the labor, but to cease abruptly as soon as the child is born. The advantage of ergot, therefore, administered some fifteen or twenty minutes before the child is born, consists in its disposition to maintain the uterine contractions till the organ is so reduced in volume that hemorrhage is prevented or arrested.

892⅔, *l*. Again, ergot has answered a useful purpose in cases of puerperal convulsions, by effecting a speedy delivery. The objections which have been made to its use in this condition, on the ground of its tendency to affect the head, appear to be hypothetical. In any thing like its therapeutical doses, the common experience of mankind has fully settled the fact that it has no tendency to induce or to increase cerebral or any other condition of disease. Its virtues appear to be limited to the vital constitution of the uterus.

The erudite Pereira, in his Materia Medica, pauses over the exhibition of ergot in puerperal convulsions, because, as he says, "The *narcotic* operation of ergot presents a serious objection to its use in cerebral affections" (§ 960, *a*).

There existed a remarkable prejudice against ergot throughout Great Britain, for many years after it had come into extensive use in other countries, on account of the stories about its having produced wide-spread epidemics at former periods. Indeed, it was not employed, I think, in England, till the year 1824, or about sixteen years after it was in successful use in America. Some of the old prejudices remain in Great Britain, and where they exist the risk of that formidable affection, puerperal convulsions, will be taken sooner than one of its most efficient means of relief will be employed. We need not inquire, in the foregoing cases, whether the os uteri be dilated, so

only labor have fairly begun. But, we may not precipitate ourselves at once upon ergot. There is something else to be done first. The patient, I say, should be first thoroughly bled, as a preliminary requisite, not only on account of the cerebral affection, but to place the whole genital organism in a most favorable state for a ready expulsion of the child. Let each remedy come in its appropriate place. A violation of their proper order of sequence may be fatal, and doubtless has been (§ 960, *a*). The specific, as it is called, is, or should be, often the last in the consecutive series. If cerebral disease be not first moderated by loss of blood, the increased uterine irritation occasioned by ergot cannot fail to increase the evil in the head of which it had been the sympathetic cause. But, loss of blood strikes both at cerebral and uterine disorder. Nor have I any doubt that, where any cerebral symptoms have sprung up after the employment of ergot in its therapeutical doses, they have been due either to entirely different causes, or the use of the agent at so early a stage of labor, that an injurious violence has been inflicted on the uterus, and thus sympathetically upon the nervous centres (§ 230). There has been great rashness in the use of ergot, from an unnatural haste of some practitioners to get rid of their patients in one way or another. It is this haste which I would reprobate, as, also, a careless administration of ergot without a due reference to a proper state of the local requisites, and its employment in such excessive doses as render uterine action injuriously violent (§ 878). In such instances, we need not be surprised at any untoward result; and, if the uterus be ruptured, or the child destroyed, or the nervous system shaken at its centre, we may not blame the remedy.

892$\frac{2}{3}$, *m.* In cases where the placenta is retained from want of proper uterine contractions, ergot, if employed soon after the birth of the child, rarely fails of its purpose. The longer, however, its administration is delayed, the less likely will it be to reproduce the uterine contractions. Nature has accomplished her great purpose after the expulsion of the child; and if, from artificial influences upon the human constitution, she pause at her remaining office, it may often be that she is prematurely started upon her recuperative process, in which she now makes all haste to her wonted station. But, whether so or not, experience assures us that uterine irritability undergoes changes very rapidly after the expulsion of the fœtus, and that, in the same ratio, the virtues of ergot lose their special relation to the organ (§ 150, 151).

892$\frac{2}{3}$, *n.* Where retention of the placenta depends upon spasmodic action of the uterus, or is owing to morbid adhesions, ergot yields no benefit, and may be injurious. The former condition certainly constitutes a serious objection to its use. The reason is, that one part of the organ is now in a more irritable state than the rest, and ergot, therefore, will act with unequal effect and increase the spasm; just as a cathartic will increase spasm of the intestine which depends upon some inflamed portion of the mucous tissue of that organ (§ 150, 151).

892$\frac{2}{3}$, *o.* Our parturient agent has shown itself capable of arresting uterine hemorrhage in the unimpregnated state, and that it is a useful agent in menorrhagia. Here it displays another attribute, and yet another differing from the astringent virtue. It does not now act as in the foregoing cases, as is evident from its failure of inducing any

of the phenomena of uterine contraction, while, moreover, the uterus is already in its contracted state. Its effect, in these cases, is like that of common salt, or of ipecacuanha, in restraining hæmoptysis. That is to say, of the individual substances, each one exerts some change in the action of the part peculiar to itself, but differing more or less from that of astringents, by which the secretion of blood is arrested (§ 904, *d*).

Again, it is said that ergot has been successfully employed in hemorrhages from the stomach, intestine, lungs, nose, and gums; all of which concurs in farther illustrating the modus operandi of the pure astringents, and of ergot in restraining menorrhagia. It should be added, however, that the anti-hemorrhagic effect of ergot, except as it respects the uterus, has been overrated.

892⅔, *p*. There have been some speculations afloat, that a poisonous influence is exerted by ergot upon the child, in utero. But, there can be no doubt that two errors are involved in this hypothesis. First, an assumption that ergot is intrinsically poisonous, and in its therapeutical doses; secondly, that an influence of the ergot is propagated from the parent to the child.

EMMENAGOGUES.

892⅔, *q*. In the foregoing sections I have been so near upon emmenagogues, and as the right treatment of amenorrhœa concerns so nearly a vast number of important cases, I shall briefly state the results of my own observation in connection with this subject, and with a view, also, of multiplying illustrations of the principles which form the ground-work of these Institutes.

Emmenagogues are arranged in my Materia Medica, under the general denomination of *Uterine Agents*, of which ergot is the first, cantharides the second, and guaiacum the third in importance. I dropped the usual denomination which appears in this section, partly with a view of moderating a common belief that suspended menstruation is to be always treated by some agent bearing the name of an emmenagogue.

All the agents comprised in this group possess virtues that exercise, more or less, extensive though various influences upon the uterine system. In consideration of this known relation, such of them as have received the appellation of emmenagogues (of which cantharides and guaiacum are the principal) are apt to be employed with a reference alone to the prominent symptoms attending amenorrhœa. But, when the failure of the uterine function stands by itself, all the emmenagogues may be inapplicable on account of some special morbid state of the uterus upon which the cessation of the discharge depends. They are always contra-indicated, cantharides and guaiacum especially, in all inflammatory and irritable states of the uterus; at least, till these conditions are overcome by antiphlogistic means. They are also inadmissible where menstruation is only suspended by some direct influences, as from exposure to cold, &c.; and they are positively injurious where the suspension depends upon sympathetic influences propagated by some active form of disease in other organs.

892⅔, *r*. In a large proportion of cases, amenorrhœa is consequent on chronic maladies of the chylopoietic viscera, and here it is that they are often administered with reference to the remote consequence;

and the condition of the important organs in which the uterine embarrassment had its origin, and by which it is commonly maintained, is apt to be overlooked or neglected. Where, however, the abdominal derangements are sufficiently pronounced to attract attention, it is not less common to look upon these primary causes as the results of a mere failure of the uterus to excrete its natural product. This interpretation comes of the humoral pathology, and is one of the every-day practical illustrations of the amount of its philosophy.

But, menstruation has a totally different final cause than humoralism imagines (§ 428–432). The evils which may arise from the failure of the evacuation depend but little upon this circumstance. They are due, on the contrary, to the morbid state of the organ through which the excretion fails; and this condition is various in its pathological nature. According, also, to the pathological state of the uterus, other things being equal, will be the nature and amount of disturbance it may inflict on other parts. In a large proportion of cases, however, the uterus suffers but little, and its function returns as soon as the remote influences are overcome.

Hence, it is obvious that the main treatment should be addressed to the organs of the abdomen, in all the cases now under consideration. The state of the uterus, it is true, reacts upon the primary and leading seats of disease; but generally feebly (§ 905, *a*). Local means should, therefore, go along with the more constitutional ones; such as leeching the perineum, exercise on horseback, the hip-bath, &c., according to the general nature of the case.

892$\frac{2}{3}$, *s*. The foregoing view of our subject inculcates a variety of treatment in the multifarious aspects of amenorrhœa, and regards all things as emmenagogue, in principle, which will restore the uterine function; though that be commonly one of the least important effects. A cathartic may be best when menstruation is suddenly arrested by exposure to the cold, or a hot bowl of motherwort may do as well. Bloodletting is the main remedy when amenorrhœa is owing to inflammation or congestion of the uterus, whether it be primary or secondary. Exercise in the open air, especially on horseback, chalybeate tonics, mercurial and aloetic laxatives, a well-regulated diet, &c., are the means when it is dependent on indigestion.

892$\frac{2}{3}$, *t*. Having accomplished the leading intentions in the chronic forms of amenorrhœa, if the uterus still fail of excreting the menses, those agents which are known as emmenagogues may now be called into use; and of these, cantharides, administered till slight strangury takes place, is not only the most efficient, but far the safest. Guaiacum is liable to irritate the stomach injuriously, and to stimulate, unfavorably, the whole system, and especially the uterus. There are many cases, however, in which the uterus may ultimately require this peculiar irritation, or where certain states of constipation will yield, happily, to the action of guaiacum; but they require a sounder reference to the exact condition of the organ than when cantharides is employed. The uterus, indeed, is so liable to an interruption of its menstrual function, that slight degrees of indigestion will establish its failure; and in these cases cantharides will generally be entirely compatible with the abdominal affection, and sufficient in itself to re-establish menstruation. But here, as in the more difficult cases, it is obvious that we should bring up the auxiliaries; as diet, exercise, &c. (§ 892$\frac{1}{2}$, *l*).

DIURETICS.

$892\frac{3}{4}$, *a.* Diuretics are agents which increase the urinary discharge, and are employed either for that purpose, or specifically, or more commonly with an indirect reference to dropsical affections, upon which they are supposed to operate by promoting the absorption of the fluid and its excretion by way of the kidneys.

$892\frac{3}{4}$, *b.* On looking over this group of remedies, it will be at once seen that it is obnoxious to objections which I have made to other groups, and that, as in the former cases, the denomination of diuretics must be received with special qualifications. Many remedies, also, are not embraced in the group which are capable of producing, under particular circumstances of disease, the most powerful diuretic effect. This is especially true of cathartics, and of some of them to so great an extent as to have procured for them the appellation of hydrogogue cathartics, or such as are capable of expelling dropsical effusions. Indeed, I may say that cathartics are better entitled to the name of diuretics than any other group of remedies; since no one of them operates upon the intestine without very generally increasing the excretion of urine; and, as to their relative effect in subduing dropsical affections, they greatly surpass the diuretics proper. The latter agents scarcely extend their influences beyond the kidneys; while cathartics accomplish their work as diuretics by overcoming the diseases upon which dropsical effusions depend, and by thus, also, withdrawing morbid sympathetic influences which those or other diseases reflect upon the kidneys, and, thirdly, by exciting the kidneys to a freer production of urine.

These remarks relative to cathartics lead me to advert to their control over dropsical affections as one of the demonstrations that dropsy depends upon inflammatory conditions. That pathological cause being removed by the antiphlogistic virtues of cathartics, the redundant effusions cease.

Bloodletting, which is not among diuretic remedies, has often as great an effect as cathartics, often greater, in establishing a copious production of urine, where it has been greatly diminished or suspended. And, from what was just said of the pathology of dropsy, it should be the best remedy, as it certainly is, in the early stages of hydrothorax and ascites.

To exemplify yet farther the nature of diuretics, and whether one thing or another will determine an increased flow of urine, and to show that this is an insignificant result of all the agents that may be employed, and that it is to the seat and pathology of disease that all our prescriptions should refer,—keeping the attention there and away from the kidneys,—I may refer to what was said of the diuretic effect of iodine in a former section, and of its modus operandi in subduing dropsy (§ $892\frac{1}{2}$, *k*).

Again, there is nothing more uniformly and powerfully diuretic than fear, which, in all its degrees and modifications, rarely fails to increase the urinary product; being, also, in its excessive operation, a most powerful sudorific, while it simultaneously determines the blood from the circumference to the centre. The boldest warrior is not without the universal instinctive principle which impels all animals to flee from danger. On the eve of battle, when most stimulated by

pride and the hope of victory, he shows that another principle is in powerful operation by the frequency with which he dismounts, or turns aside from the ranks, to let off troublesome accumulations of urine. And just so with man whenever dangers impend; whether they threaten his life, his limb, or his reputation. And so with any event in the success of which he has an immediate interest. All this, too, is equally true of animals; and it all conspires in showing that humoralism, and "dynamic" and "quantitive" chemistry, are upon the wrong track, and that the name of diuretics has been one of the causes of leading physicians to prescribe for a symptom, instead of seeking out and subduing disease by its appropriate remedies.

But, there is a vast variety remaining of the foregoing nature. Take a modification of fear, as showing the delicate shades of difference among the passions, and how they correspond in their effects, and in their organic influences, with material agents. Thus, anxiety, which has fear for one of its elements, exerts, also, a like but modified effect upon man. So, again, jealousy, which results from the united operation of fear and love (§ 188½, *d*). Thus Sappho:

> "In dewy drops my limbs were chilled,
> My blood with gentle horrors thrilled,
> My feeble pulse forgot to play,
> I fainted, sunk, and died away."

And, coming to the pure element, love itself, we observe other coincidences with fear; especially as it respects perspiration. In excessive joy, also, we meet with another powerful diuretic, as, likewise, in the sympathy between man and man. But it is manifest, in all these cases, that each agent, each passion, produces influences peculiar to itself, each one in its individual or its compound aspect. It is variously illustrated in the following sections: 227, 228 *b*, 233¾, 234 *e*, 500 *c*, *g*, *k*, *n*, 512, 652 *c*, 827 *c*, 828 *a*, 844 *a*, 902 *g*, 904 *d*, and in other places; while it may be said, in respect to the passions, that we may discern in the different conditions of the perspirable matter, and in the different states of the skin, indications of different organic influences that are exerted by the nervous power, and carry the same conclusions to other parts which may be impressed in their organic states (§ 227, 228 *a*, &c.). The same is true, also, of those emotions which are awakened by physical influences. Certain odors prove diuretic to some and cathartic to others; and, as affirmed by Shakspeare,

> "——— others, when the bag-pipe sings i' th' nose,
> Cannot contain their urine for affection.
> Masterless passion sways it in the mood,
> Of what it likes or loathes."

The last is analogous in its philosophy to what is said of light in section 514, *l*. And as to offensive sounds, which fall under the same category, it is related by Dr. Fairfax that, "Mistress Raymond, whenever she hears it thunder, even afar off, begins to have a bodily distemper seize her. She grows faint, sick in her stomach, and ready to vomit. At the very coming over of the thunder, she falls into a downright cholera, and continues under a violent vomiting and purging as long as the tempest lasts. And thus hath it been with this gentlewoman from a girl." Beddoes speaks of analogous results. "At any moment," he says, "inflammation may be kindled in any part by some causes which we cannot distinguish; by others too subtle for

our senses, as, perhaps, by a thunder cloud passing over head" (§ 230, 828 *c*). Until the nature of lightning was understood, it was supposed that it corrupted the blood in such cases. But, later "experimental philosophy" has enabled the chemist to expound it in another way, and to the easy comprehension of most people (§ 349, *d*, *e*), while the few take a more circuitous method (§ 222–233$\frac{3}{4}$, 500, 893–905), although at no little peril (§ 5$\frac{1}{2}$, *a*). Again, cold, applied suddenly to the surface of the body, is often a powerful diuretic (§ 422, 423). But, although neither this nor the preceding causes are ranked as diuretics, they are probably about as much entitled to this designation as those agents to which it is specifically appropriated.

892$\frac{3}{4}$, *c*. The agents and causes of which I have now spoken, disclose the whole philosophy of the operation of such as are especially denominated diuretics, and expose the fallacy of the humoral, chemical, and mechanical interpretations.

Whether, therefore, it be loss of blood, or cathartics, or cold applied to the surface, or the operation of fear, or other mental emotions, which increase the excretion of urine, they all do it by acting directly or indirectly upon the organic properties of the kidneys, and mostly through the medium of the nervous power. Loss of blood may be directly exerted upon the organs, or it may be, as is generally true, through the instrumentality of the nervous system, by removing disease from some other part, as the liver (which is a common example), and which had sympathetically diminished the excretion of urine. The principles, as it respects the nervous power, and the change of organic actions, are the same with cold, fear, &c. Coming, lastly, to the diuretics proper, such as are truly remedial produce their effects, also, upon exactly the same principles (§ 277). Nevertheless, it is undoubted that certain substances of mild remedial virtues, especially such as are not offensive to the lacteals, or to the general organism, gain admittance more or less readily into the circulation; and, coming in contact with the kidneys, may stimulate, and increase the action of, these organs. Such, for example, are certain neutral salts. Probably the acetates of potass and soda may produce their effects upon the kidneys more or less in this way; though certainly, also, through the nervous influence when they prove cathartic. In respect to these two agents, however, the chemical and humoral theorists are not all satisfied with their general hypothesis (§ 278).

Nor is it at all surprising that the functions of the skin and kidneys should be so readily affected by the nervous influence, as developed by the foregoing causes, moral and physical, when we consider the final causes of each of the organs, and that Nature has ordained for their fulfillment a great versatility of action, and that, therefore, morbific and remedial agents will operate variously, according to their several virtues, through that natural constitution of the organs (§ 423, 513, 902 *f*, *g*). This consideration also lets us into the reason why the urine flows so abundantly after some fluids, such as gin (which contains the diuretic juniper), and in some cases before there can have been time for their incorporation with the blood; a fact, indeed, so often observed, that many physiologists have supposed that there must be some more direct communication between the stomach and bladder than by the ordinary route of the absorbents, &c.

892$\frac{3}{4}$, *d*. The "diuretics proper" are the least useful of all the an-

tiphlogistics; having but little effect upon inflammations or fevers. Yet are they often prescribed in high grades of those affections (where the urine is greatly deficient), in the vain expectation of reaching those profound lesions by the removal of one of their least important sympathetic consequences. Their use, however, with the more enlightened, is now mainly limited to dropsical effusions in the great cavities and the extremities; however defective may be the pathology, or however inefficient these agents are compared with bloodletting, cathartics, blisters, mercury, iodine, &c. They are always most useful in cases that are benefited by loss of blood and by cathartics.

892$\frac{3}{4}$, *e*. Some of the diuretics which possess compound virtues, such as squill, and Indian hemp (*apocynum cannabinum*), may prove very detrimental in many cases of dropsy; the former, for example, by its acrid, stimulating virtue, the latter by its severe action upon the intestinal canal. Where mercurial agents are employed, they should be well chosen, and according to the existing pathological states. In the simple form of dropsy, or if inflammation exist in any degree of activity, as in the serous tissue, or in the liver, then some one of the simple mercurials should be selected, as calomel, or blue pill; preceded, however, by loss of blood, &c. If, on the other hand, the dropsical effusion have existed a good while, or be attended by chronic enlargement of the liver, or of some other viscus, the mercurial should be chosen with reference to such organic affections; though calomel or blue pill may answer well. But, in these cases, the iodides and bromides of mercury are the most appropriate; and now we may, sooner or later, employ squill with or without other diuretics, though it is commonly most useful to combine two or more together. If the subject be of a scrofulous habit, iodine should be used freely.

892$\frac{3}{4}$, *f*. Much has been said of the connection of renal disease with dropsy, and many physicians have, in consequence, gone into a chemical analysis of the urine, instead of the signs to be observed in the body, for an exposition of the nature of disease. But, so many coincidences have sprung up from other causes, that it may be expected that this "experimental philosophy" will not endure.

892$\frac{3}{4}$, *g*. The greatest of all the errors in relation to dropsical affections, is that which divides them into active and passive. This error appears to have grown out of another—that which makes the same distinction of inflammations (§ 752, &c.); though, in the former case, the relative states of pathology are supposed to be in even greater opposition. The practice proceeds upon the same hypothesis as that which concerns the distinctions in inflammation.

EXPECTORANTS.

892$\frac{4}{5}$, *a*. This group of agents have had too large a connection with disease to be neglected; or, at least, not to be held responsible for any mischief they may have done. Like many other denominations, the term is significant of their most visible effect, although, like many others, it is one of the least important in a large proportion of the diseases where they are employed, while the most important can be obtained only by remedies that do not fall within the group.

The tendency of the name, and the definition which is given of expectorants, have turned a great amount of attention upon the quantity

of matter expectorated, and away from those pathological conditions upon which the physical product depends (§ 889 *c*, 891 *d*, *o*).

It is greatly, therefore, with expectorants as with sudorifics, diuretics, &c. The secreted product is only a secondary result; complicated and various in respect to the conditions and influences by which it is brought about, and capable of being increased or produced, under different vital states of the body, by agents of entirely opposite virtues,—by the most direct sedatives, and by the most active stimulants. Every thing, therefore, which will, under any contingencies of disease, increase or produce expectoration, is more or less entitled to be considered an expectorant. Hence, it is apparent that, whenever remedies are applied with a view to the supposed objects of expectorants, they are quite likely to aggravate formidable grades of disease, or to leave the subject, at least, to an unresisted fate which might have been averted by appropriate means.

892$\frac{4}{5}$, *b*. In my *Arrangement of the Materia Medica*, I have placed some agents, under the denomination of expectorants, as first in importance, which others, who consider mostly the result upon which the group has been founded, would rank lower down. But, as the foundation of my arrangement relates to the therapeutical capabilities of the various substances, I have designated tartarized antimony as the first, and ipecacuanha the second in importance. These agents, in a general sense, are most useful under the condition in which expectoration is desirable, if relief be not obtained without; though it may or may not be a result of their action. It is now, as when sweating may take place profusely, moderately, or not at all, from what are denominated sudorifics. But, I should say that the parallel does not hold strictly in these cases; since the sympathies between the stomach and skin are so far different from those which prevail between the stomach and the lungs, that mild impressions made upon the stomach, as by hot water, will determine profuse perspiration, or, as in other cases, irritating food will occasion, speedily, eruptions of the skin; while none but agents of considerable power will institute sympathetic actions in the lungs, or give rise to that expectoration which grows out of such actions. All the expectorants, therefore, of any importance are capable of exerting powerful effects, either for good or for evil; while, of all the sudorifics, tartarized antimony and ipecacuanha are the only ones that are entitled to consideration on account of their virtues.

Again: sympathies, as determined by the operation of agents upon the stomach, depend not only upon the nature of the agents, the natural function of the sympathizing part, and the particular mode in which it may be affected by disease, but upon the analogies that may subsist in the structure and vital constitution of the mucous tissue of the stomach and the part remotely influenced (§ 133–152, 525–529). The group of remedies now before us refer to a tissue of the same species as that of the stomach upon which the remedial agents exert their direct effect; and the sympathetic effect upon the pulmonary mucous tissue, when induced by remedial agents applied to the stomach, are, for this reason in part, different from such as are exerted by the stomach upon the skin, and are generally much more profound, and of a more alterative nature.

892$\frac{4}{5}$, *c*. The effect of remedies, therefore, in their acceptation of

expectorants, being determined by the existing condition of disease, and more or less by the state of the system at large, and conditions not much allied admitting the agency of remedies that operate as expectorants, it is clear that we must have a classification of these remedies according to their general virtues. I have, therefore, more or less after the manner of others, distributed them into five subdivisions. These I shall now state, along with the several agents embraced under each subdivision; and, for the purpose of illustrating my conceptions of their relative bearing upon disease, and with only a secondary view to the expectoration which they may be, respectively, capable of producing, I shall designate each one by numbers that denote their order of arrangement, and their relative therapeutical uses where expectoration is a desirable consequence if the remedy do not succeed without.

Non-stimulating.—1. Potassæ antimonio-tartras. 2. Cephælis ipecacuanha. 4. Gillenia trifoliata. 6. Asclepias tuberosa.

Stimulating.—3. Scilla maritima. 7. Polygala senega. 8. Dorema ammoniacum. 10. Opopanax chironium. 13. Eryngium aquaticum. 14. Myrospermum toluiferum. 15. Myrospermum peruiferum. 16. Naphthaline. 17. Styrax benzoin. 18. Styrax officinale. 19. Liquidambar styraciflua. 20. Amyris gileadensis. 21. Allium sativum. 22. Erysimum alliaria. 23. Sisymbrium officinale.

Stimulating and Narcotic.—5. Sanguinaria canadensis.

Sedative and Narcotic.—11. Lobelia inflata.

Stimulating and Antispasmodic.— 9. Ferula asafœtida. Ferula persica. 12. Galbanum officinale.

It will be seen, therefore, from the foregoing general distribution of expectorants, that four of them only are adapted to any thing like acute inflammation of any tissue of the lungs; and that the first two only are wanted. Moreover, none of the expectorants are ever employed excepting in some inflammatory state of those organs; or, at least, according to my views of all the pathological conditions for the relief of which the expectorants are intended. And when it is considered, also, how very irritable and susceptible the lungs are when affected in their parenchymatous structure, and even those parts of the mucous tissue which line the bronchi, larynx, and trachea; how liable, too, inflammation is to be propagated from the upper portions into the air-cells; how many there are in whom pulmonary phthisis is readily awakened by inflammatory states of this membrane; how they constantly throw morbific influences over the stomach, the intestine, the general organs of circulation, &c.; and how often inflammation of the tracheal portion of the membrane eventuates in ulceration; besides other sequelæ of inferior moment; it becomes apparent that this group of remedies, with the exception of the two leading members, has numbered its victims next after those agents which form the groups of tonics and stimulants.

Why, then, it is asked, perhaps, does the squill rank, in the arrangement, as the third in therapeutical value, and before the non-stimulant American ipecacuanha, bloodroot as the fifth, seneka the seventh, gum ammoniac the eighth, and these last three before asafetida, &c.? The answer is important, although the order of arrangement assumed that the reader was sufficiently conversant with the principles upon which it is founded. It assumed, in the first place, that he was famil-

iar with the general structure of the lungs, that he had some ideas about a "chemical" difference, at least, in the relations of different portions of the pulmonary mucous tissue to this group of remedies (§ 134–143); that he was aware of the inflammatory nature of the disease for which he was prescribing, as well as its exact seat; that he distinguished between acute and chronic forms of inflammation; that he understood, that, as one portion or another of the pulmonary mucous tissue might be the seat of disease, and according to the special modification of disease, it might be relieved or increased by different expectorants, and according, also, as the premises might be, he foresaw that this or that expectorant might develop tuberculous phthisis, or become the indirect cause of disease in other parts, &c.

Proceeding, therefore, upon these hypotheses, and as chronic inflammation of the mucous tissue of the trachea and bronchi is a very common form of disease, and is often benefited, in constitutions that are otherwise sound, by a stimulating expectorant, it was important that some one, at least, should occupy a high place in the *Arrangement.* But, it should be also one whose virtues are most of an alterative nature, but most exempt from morbific tendencies; whence it becomes plain that the scilla maritima should stand immediately after the cephælis ipecacuanha. It should also precede the gillenia, since the virtues of this last, as, also, of the asclepias, are analogous to those of the great tenant of Brazil, yet much inferior. But, comparatively unimportant as the gillenia and asclepias may be, they are yet so analogous to ipecacuanha, that they may stand in its stead, and being of easy access to the American practitioner, they should follow near upon the other two non-stimulant expectorants; gillenia taking the precedence of the asclepias on account of its greater alterative virtues.

Asafetida, I am aware, is a favorite expectorant with many; but it is less alterative than seneka, and the preceding gums, and is much more liable to offend the stomach.

As to bloodroot, that substance stands, like castor oil, alone in the Materia Medica. It is capable of peculiar influences; but, as they are oftener injurious than beneficial, I have given to it a higher rank than was warranted by my own experience or by that of some others. It has been, however, highly commended; and in deference, therefore, to that more favorable experience, it appeared to me that it should occupy a place in the Arrangement that might yield to the remedy a fair opportunity for more ample observation of its effects, so far as my Arrangement might have any influence.

The foregoing analysis will serve, also, for the disposition which I have made of the members of all other groups. The arrangement bears upon its face the author's conceptions of their special relations either to pathological conditions that are most allied, or to such as are diverted from the common forms, or to others which are distinguished by greater peculiarities; while, also, each, by their order, under the various assemblages, denotes its therapeutical capabilities. If the author, therefore, be right in his premises upon which the arrangement is founded, each article is thus rendered more or less descriptive of its own uses, &c. (§ 892, *aa*, *c*).

892$\frac{4}{5}$, *d.* There should be no difficulty with correct observers in reaching a knowledge of the conditions of disease to which remedial agents of such various and even opposite virtues as the expectorants

are adapted. The general principles of pathology and therapeutics go far in indicating, at once, which of the groups are properly suited to certain pathological states, which of its members is best adapted to any modified condition of the general pathology, or which of the groups, or which members of the proper group, should be avoided. But, a nice discrimination of the variously-modified forms of inflammation, whether as to its nature, intensity, duration, complications, &c., and a precise acquaintance with the peculiarities of each remedial agent, will be often necessary to guide us to the just regulation of influences which any given combination of symptoms may demand; or, proceeding blindly to execute the results of an *expectorant*, in its ordinary acceptation, and under the belief that each substance so denominated will alike fulfill the intention, we may as readily destroy the patient, in the end, by this indiscriminate practice, as we might, with certainty, relieve him by a choice of other means bearing the same general name of expectorants. It is not, therefore, I say, the abstract fact of expectoration that we are to regard, but this is to be considered as a result of a favorable action which certain remedial agents are capable of instituting, but which very often fail of that result when their action is in the highest degree salubrious. On the contrary, also, we shall see that expectoration may be increased by increasing the morbid conditions; just as the discharge of mucus, in intestinal inflammation, is increased by an irritating cathartic. The only difference consists in the direct action of the morbific irritant upon the affected part, in one case, and its indirect action through the nervous power, in the other (§ 150, 151, 226, 228, 229). It is, therefore, far from being true that the remedy is appropriate when the discharge from the lungs is promoted and increased, even though an expectorant be especially indicated, and the proper one may even tend to lessen the quantity of mucus; provided it facilitate its ejection and lessen the morbid action upon which it depends.

892½, *e.* We see, therefore, more and more, how indispensable it is to look upon results as indicative only of certain complex vital conditions which should be ascertained, and, as far as possible, to regard the proximate causes in all our prescriptions (§ 673, 674, 699, 741). Here we have a patient with a cough. A favorable or a fatal issue of his case may depend entirely upon the exhibition of the right expectorant. He may be cured by tartarized antimony, or may be killed by squill, seneka, or bloodroot. It is evident, therefore, that "coughs" depend upon important varieties of pathological conditions; though, when the direct result of pulmonary disease, those conditions are generally of an inflammatory nature. There may be numerous gradations of the form of common inflammation from that which constitutes pneumonia, and speedily runs its course, to that indolent state which persists for years, and makes little or no impression upon the general health.

All this, however, is doubtless obvious to enlightened practitioners; but, when it is considered what morbid anatomy is about, even with common inflammation (§ 699), and, how deplorable the evils which have sprung from the pathology of scrofula and tuberculous phthisis that has issued from the purlieus of Paris, I am moved by the conviction that I cannot attempt a more useful service to humanity than by exploring the subject now under consideration.

It has been no uncommon and fatal error to have exhibited stimu-

lating expectorants (which, indeed, commonly form the "cough mixtures"), in active forms of pneumonia, under the belief that these stimulating agents possess the power of at all times producing expectoration, and that this result is the main object to be contemplated. Sometimes, however, these agents produce vomiting, and their effects are then less disastrous; or, in subdued forms of acute inflammation, this universal influence may barely counteract the stimulant virtue, or it may be useful.

892$\frac{4}{5}$, *f.* Coming to special modifications of inflammation, the expectorants in common use perform their morbific work according to the variety of the disease, and the part of the pulmonary mucous tissue, or other tissue of the lungs, in which it may hold its seat.

Readily as that modification which constitutes croup may be removed in its early stages, a pernicious custom exists of prescribing stimulating expectorants. It is true, they are often united with tartarized antimony in the treatment of this disease; and a formula of this kind exists in the United States Pharmacopœia, bearing the name of the *Compound Honey of Squill.* That may be well enough, unaccompanied with directions for its use, with the exception of the honey, which is of no use whatever, never fails to injure the stomach, and often produces colic in healthy people. But, the compound is *there*, however, with the obvious design of supplying a convenient resource to the practitioner in cases of "cough," and especially that which attends the croup. In Wood and Bache's Dispensatory, of which the United States Pharmacopœia forms an important basis, it is said by the editors, that it "requires an explanatory commentary, in order that its precepts may be fully appreciated, and advantageously put into practice." Now, after stating that formula, the editors remark, that "this is the preparation commonly known by the name of *Coxe's Hive Syrup.*" Indeed, such is the translation of the original name. Thus:

"Mel Scillæ Compositum. U. S. *Compound Syrup of Squill. Hive Syrup.*"

In this are four ounces, each, of squill and seneka, and two pounds of clarified honey, along with four pints of water and forty-eight grains of tartarized antimony, boiled down to three pints, or about three pounds.

Such, then, is a standing formula for croup, with the very name of the disease associated with it; and a more dangerous weapon was never put into the hands of the profession. Compared with the lancet, which is so often represented in a similar manner, the ratio is about the same as computed by Smith between the "hero and the murderer" (§ 569, *e*). In all the cases, however, the questions at issue are to be decided by the force of facts.

If the mischief attendant on the "Hive Syrup" were limited to croup alone, these remarks, perhaps, had never been written. But, "cough" upon "cough," reaching even to all the stages of pulmonary phthisis, make their frequent demands upon "Hive Syrup." The antimony which it embraces atones but little for the offenses of its associates in most of the cases where they are called into action.

892$\frac{4}{5}$, *g.* It is *resolution*, not expectoration, which is wanted, when it can be obtained, in all the cases of active inflammation,—ay, in all of pulmonary phthisis before suppuration supervenes (§ 700 *b*, 705,

732 *d*, 862–864, 890 *e*). If the disease be of such intensity that resolution may not be effected by tartarized antimony or ipecacuanha, no time should be lost in calling upon general or local bloodletting, cathartics, blisters, &c. And when we consider how these accomplish the intention to which the expectorants are inadequate only from the force of disease, it will go with the many other analogous considerations which appear in this work toward clearing up the philosophy which relates to the operation of expectorants, whether in their curative or morbific relations to disease. Or, again, if bloodletting fail of arresting pneumonia, for example, we may pursue the philosophy in another aspect; since, while it has relieved the violence of the malady, it has brought on expectoration. It has so modified the inflammatory condition, that mucus is generated in preternatural quantities; and therefore we see that bloodletting itself may operate as an expectorant. We now exhibit tartarized antimony, and it may either increase or diminish the expectoration; and, in doing either, it contributes to the decline of the disease. The expectoration, therefore, is a mere result, a mere symptom, of a certain change in the action of the organs by which the mucus is secreted; and it may be the result of a favorable or an unfavorable change. It appears, therefore, that whether the agent will or will not increase the mucous product, or, on the other hand, diminish it, depends upon the exact influence it may exert upon the pathological condition. All this clearly brings the operation of the several agents upon a par, and admonishes us to study their virtues, their mode of operating, and the precise conditions of disease to which one or the other may be applicable.

But, let us pursue yet farther the case of pneumonia. Let us suppose a slow termination of disease. Antimonials finally cease to bestow any farther benefit, and the cough has subsided into one of a low chronic nature, without much expectoration. Here it is, if there be no strong tendency to scrofula, that squill, seneka, and other stimulating expectorants, may become highly useful; and if the cough be frequent and short, denoting an irritable state of the lungs, we associate an opiate, which not only allays the cough and moderates the stimulant effect of the expectorants, but increases the expectoration; and thus the opiate becomes an expectorant, though neither this nor bloodletting are ranked in that group of remedies.

A blister is also applied to the affected chest, and now, again, expectoration either increases or declines; though, in either case, there is a manifest abatement of disease as a consequence of the counter irritation.

But, perhaps the cough has ultimately become complicated with disordered digestion, or, it may be chiefly maintained by some gastric derangement. It is dry, and the usual expectorants render it still more irritating and husky. The remedy, therefore, is wrong, and has not been addressed to the essential pathological condition; which consists of some derangement of the stomach, while that of the lungs has become mostly sympathetic. Whatever will now relieve the former affection may remove the pulmonic. For this purpose tonics may be useful, and, as relief follows in the lungs, expectoration may be one of the results (§ 905). Tonics, therefore, in cases of this nature, become expectorants, and equally so as any of the agents which are confined to this denomination of remedies. It is obvious, too, that

they all operate upon common principles when they promote expectoration; and whether the result will follow one or the other, will depend upon the existing state of the system, in a general sense, and more particularly upon the precise pathological condition of the lungs. It is apparent, therefore, that remedies from almost any group may be expectorant; bloodletting, cathartics, emetics, narcotics, tonics, counter-irritants, and even alcohol. The last, indeed, in the form of hot toddy, is a popular remedy for colds. It may or may not increase expectoration. It may relieve, but more generally aggravates the disease (§ 756).

Old neglected coughs from ordinary catarrh, and what is known as the old man's cough, come under that condition of common inflammation to which the stimulating expectorants are adapted. But, however protracted may be the specific varieties, as in hooping-cough, and pulmonary phthisis, they cannot be employed without endangering life. Their effect, indeed, in hooping-cough, is so obviously bad, that they are not often employed in its treatment; but, in pulmonary phthisis, and especially in the catarrhal affections of scrofulous constitutions, we every day witness the penalties which are paid for substituting morbid anatomy for the vital signs of disease, and in defiance of the plainest demonstrations which therapeutical agents can supply (§ 137, *c*).

892⅘, *h*. The sympathies to which the lungs are liable from many diseases of other parts, especially of the digestive organs, and the more or less reciprocal effects of their own diseases, by which a vast complexity of sympathies may be set in operation, together with the situation of the lungs in a bony cavity, frequently render it difficult to ascertain their exact pathological conditions, and to distinguish what may appertain to pulmonary disease from what may be due to the play of sympathies. The stethescope, like the long-established method of percussion, has contributed much to clearing away the obscurities, and has done its good part in substituting pathological considerations for mere effects, and has shown us that cough, difficulty of breathing, &c., are not diseases, but merely symptoms of disease. The scientific physician, therefore, no longer administers expectorants, &c., for the relief of cough, or dyspnœa, but he applies the various agents to overcome pneumonia, pleuritis, bronchitis, laryngitis, pharyngitis, &c. In one case there is something tangible, intelligible, and susceptible of certain and speedy relief; in the other, or where the prescription is made to the symptom alone, all is confusion, uncertainty, and death. Or, it may be some organic affection of the heart, or gastritis, or enteritis, or little more than moderate degrees of indigestion, upon which the cough or dyspnœa depends and yet where, from want of a proper anatomical knowledge, or of physiological and pathological science, the most unhappy mistakes are made with the expectorants, but where the better informed are often greatly aided, in their embarrassments, by the stethescope.

But great as is the acquisition of the stethescope, the reign of morbid anatomy has surrounded it with many abuses; the vital signs are either neglected or held to be of very subordinate importance, and the instrument is turned in pursuit of structural lesions. If cough and dyspnœa supervene upon abdominal derangements, the source of the symptoms is sure to be found in some special region of the heart, or, others

detect in the supposed organic lesions the cause of an intermittent or irregular pulse that depends on hepatic disorder (§ 390 *b*, 688 *k*, 806, 811). These mistakes are sometimes witnessed in this country as the consequences of Parisian and British pathology.

892$\frac{4}{5}$, *i*. The foregoing considerations appear to be indispensable to all who would enter understandingly upon the treatment of pulmonary affections, or to distinguish what is relative to the lungs from what is due to other organs, or to comprehend the modus operandi of the remedial agents, whether they be employed under the denomination of antiphlogistics, vesicants, pectorals, expectorants, &c., or their philosophical and comprehensive name of alteratives.

To the young practitioner, at least, I would say that it should never be forgotten that every inflammatory state of the mucous tissue of the lungs, however mild or chronic, is liable to become exasperated, and to give rise to pneumonia, or to croup, or what is extremely common, to phthisis pulmonalis. And when we again consider how often the last affection has been developed by the stimulating expectorants, I think that I do not err in my estimate of their relative uses and destructive effects, in saying that mankind would be benefited by excluding from the treatment of pulmonary diseases all the reputed members of that group of remedies excepting those which belong to the first of the foregoing subdivision (§ 892$\frac{4}{5}$, *c*). Independently of the direct practical results, attention would be turned upon bloodletting, antimonials, &c., and their strikingly salutary effects in numerous cases of common inflammation of the pulmonary mucous tissue, and in the early stages, especially, of those inflammatory states which lead to pulmonary phthisis, would revolutionize the whole system of morbid anatomy, and eradicate the pathology which has been founded upon it.

In the next edition of my Materia Medica (and I make the suggestion on account of its practical bearing), it is my intention to substitute for the term *Expectorants* another which shall refer to their modus operandi; probably, *Alteratives adapted to Pulmonic Inflammations*, and I will rank *bloodletting* as the first, in a general sense. This will take in, also, tartarized antimony, and ipecacuanha, in emetic doses. Its advantages may be variously illustrated. Almost any condition, for example, of muco-pulmonic inflammation may be accompanied with a strong predisposition to inflammation of the pleura, or, they may occur together, or in the form of pleuro-pneumonia. Very many turn directly to the expectorants, and, if they find their attention arrested at once, under an equivalent denomination, by bloodletting, and tartarized antimony, and unfettered by the term expectorants, the appropriate remedies may have a good chance of raising inquiry, and their trial may awaken new views in pathology, and dissipate some of the prejudices against loss of blood. The practitioner will soon imbibe the conviction which experiment produced in the distinguished Cleghorn, that bloodletting can scarcely be misapplied under any conditions of pneumonia, and be led to avoid the stimulating expectorants, as he will all the tonics, when he approaches the treatment of most inflammatory affections (§ 1005, *h*). In proportion as the loss of blood is less likely to be useful where any form of pulmonic inflammation, to which this remedy may be adapted, shall refuse to yield to its power, so in a greater ratio will the non-stimulating ex-

pectorants, and all other means, be likely to fail. How unavailing, therefore, must be those stimulating expectorants which are so often prescribed, even by those who confide in early bloodletting, at the advanced stages of pneumonia! The sole object in view is that of increasing or starting expectoration, without any reference to the morbific virtues of the supposed remedy. Let us, therefore, have the best remedy, however late, whatever the sex, whatever the constitution or the age; and that remedy, in the cases supposed, will be the loss of blood, as affording the best chance for life. Whenever acute forms of inflammation subside into a chronic state, neither the pathology nor the principles of treatment change, unless as it respects partial modifications. In a general sense, the direct antiphlogistic plan should be continued (§ 752, &c., 1007 *b*, *c*, *d*, 1008).

In the language of the celebrated Dr. Freind, "There are some, perhaps, who may think these various inquiries into disease may not be of much service to the healing art. However, they must allow me to affirm, that it is of very great importance to physic, that we have an accurate knowledge both of the peculiar signs and of the nature of each distemper, and, also, of its seat; for these being found, we shall be much happier in our inquiries into the means of cure. Whoever, therefore, perfectly understands the nature of a pleurisy, or peripneumony, will easily perceive what immediate relief may be had from opening a vein; for, upon this point so depends the whole safety of the patients, that, if you should depart from this kind of medicine, in vain will you seek for any other."

But, I would finally say of pneumonia, that however the disease may abate under the direct effect of loss of blood, it not unfrequently happens that the symptoms recur with more or less violence. It is this which we are to anticipate and watch, and to repeat the remedy from time to time, as returning symptoms may suggest, and before the disease can have recovered its original severity (§ 1005, *h*). In this manner, we shall constantly make advances upon it, and, with the aid of other remedies judiciously devised, we shall not often fail of success. These, however, are cases in which firmness, and a constant recourse to pathological considerations, are more or less in requisition. Sanguine hopes may be called up by the great relief which is yielded by the first outlet of blood, but, to be only in a few hours disappointed by the formidable signs of returning inflammation; and when, at last, we shall have met them again and again by our principal remedy, the disease may appear to have come to a stand, and scarce falters under the combined effect of general bloodletting, leeching, antimonials, &c. This is no time for discouragement, but rather to fear that our means, in coming short of the mark, have not been applied in sufficient vigor. Now is the time, I say, to push the high principles of our noble science, to throw off the trammels of prejudice, and let the blood flow, till, by the relief it brings, we win new trophies for ourselves, and for medicine (§ 1005 *a*, *b*, *c*, *d*, *e*, *f*, *g*, *h*, 1007 *b*, *c*, *d*, 1008).

COUNTER-IRRITANTS.

893, *a*. I enter now upon the consideration of those remedial agents which estaolish their influences upon internal organs through the medium of the skin; and here is opened to us a display of those sympa-

thetic processes which take their origin in cerebro-spinal nerves along with the sensitive fibres of the sympathetic, and terminate in the motor fibres of the ganglionic system.

893, *b*. In my Arrangement of the Materia Medica I have embraced counter-irritants, with numerous other agents, under the general denomination of *Cutaneous and other Local Applications*.

This extensive group forms the eighth Order of the first Class, or Antiphlogistics. Very many of this order are purely local in their action, while others affect the constitution more or less at large. Such, therefore, as are relative to the skin I have subdivided in conformity with those local and general influences. These subdivisions are founded, like the other groups, upon certain special uses or effects, and give to this complex order all the analytical simplicity that can be wanted.

The following are the various groups into which I have distributed the members of this general Order:—1. *Vesicants*. 2. *Rubefacients*. 3. *Suppurants*. 4. *Escharotics*. 5. *Potential Cauterants*. 6. *Actual Cauterants*. 7. *Local Alteratives*. 8. *Local Sedatives*. 9. *Local Astringents*. 10. *Simple Remedies*. These are relative to the surface.

Then follow *Injections*, which comprise *Enemas*, *Uterine*, *Vaginal*, and *Urethral Injections*.

And then we have *Gargles*, and Injections for the *Ear*. Lastly, *Collyria*.

Of the ten sub-groups which concern the skin, one is far more comprehensive and complex than the rest; which, indeed, are sufficiently simple. That assemblage of greater variety and intricacy I have designated as *alterative;* not because the agents of the other subdivisions do not operate more or less upon the same principles, but because these latter have prominent local effects upon which the several groups may be founded; while in respect to the *Alteratives* emphatically so called, their operation proceeds without any prominent local result.

It appears, therefore, that the remedies under the present Order observe the same laws as those which are administered by the stomach, and are productive of analogous results. It is also remarkable, that, while all the agents of the several Orders, comprised under the various Classes, operate as alteratives, either locally or constitutionally, the most comprehensive Orders, whether administered by the stomach, or applied to the surface, are, of necessity, designated as *Alteratives*, on account of the general absence of any prominent effect upon which a more specific denomination might be founded. They embrace, also, all the most profoundly curative agents, the most violent poisons in Nature; and yet do they generally bring about the restorative process without any other demonstration; so only their employment be directed by sound therapeutical principles. And what a commentary this upon the doctrine of remedial action by absorption, and upon those pursuits which would elicit therapeutical virtues from experiments upon animals or upon man in health, either with poisons or with agents which are inert in those relations!

Finally, I have carried out the same practical rule in the arrangement of the Cutaneous Alteratives, as I have employed in respect to such as operate through the intestinal mucous tissue; having subdivided them into

Constitutional Alteratives, or such as affect distant organs, or the constitution at large, sympathetically; and *Local Alteratives*, or those

whose action is either confined to the skin, or which operate upon parts beneath by contiguous sympathy. The *Local Alteratives* I have subdivided, again, into,

1. Such as are adapted to cutaneous diseases.
2. Such as are adapted to scrofulous and other indolent tumors, chronic enlargements of the joints, &c.
3. Such as are adapted to rheumatic inflammation.
4. Such as are adapted to neuralgia and neuralgic rheumatism.
5. Such as are adapted to certain conditions of erysipelas, and some other cutaneous inflammations of specific character.
6. Such as are adapted to sprains, &c.
7. Such as are adapted to piles.
8. Such as are adapted to carcinomatous ulcers.
9. Such as are adapted to phagedenic and tuberculous ulcers, &c.

As in respect to all other general or partial groups, the several members of the eighth Order of Antiphlogistics are arranged in the order of their established therapeutical value, under the various denominations.

893, *c*. Vesicants are by far the most important in this Order of Antiphlogistics; though their importance scarcely extends beyond the genus *cantharis*. The next following five groups, however, namely, *rubefacients, suppurants, escharotics, potential cauterants,* and *actual cauterants*, operate more or less after the manner of the *vesicants*, both upon the skin and by sympathy. But, escharotics, potential and actual cauterants, are generally limited to simply local effects; and then their action is exerted directly upon the organic constitution of the part, and without any intervention of the nervous power in the results which follow. When more extensive, the nervous power is called into operation, and the difference in results will depend much upon the manner in which the several applications are made.

Whenever vesicants, or the other agents, included in the first subdivision, affect diseased parts which are more or less distant from the skin, their action upon such parts is mainly by contiguous sympathy (§ 497, 905). These agents, however, occasionally afford strong manifestations of a more extensive influence; and this, especially, in irritable habits, or where peculiar relations may exist toward the remedial virtues of any particular agent. It is in this way that cantharides will generally produce strangury in some constitutions, however remotely from the urinary organs the application may be made. This, indeed, it will do as readily when applied to the extremities as over the region of the bladder; while, on the other hand, where that special susceptibility of the bladder does not exist, the vesicant may be as safely applied in that quarter as in any other, even though the organ be the seat of inflammation (§ 137 *d*, 150, 233¾, 585 *b*). Again, also, when irritations are established in the skin by vesicants, leading to irritative inflammation, which is often the case with children, and in the sanguine and nervous temperaments, or in others where general irritability is morbidly increased, the nervous power may be brought into general operation, and we may witness the full development of remote sympathies in one almost universal commotion of the body (§ 150, 151, 514 *d*). This may also follow too extensive an application of a blister, or of rubefacients, though no excessive irritation be produced in the skin; just as a scald of limited extent may be

salutary, while another less intense, but spreading over a greater surface, will be often fatal. In all these cases, however, the effect is morbific, and they exemplify the very close analogy between the operation of morbific and remedial agents (§ 901). It is, indeed, the amount of the agent, whether physical or moral, and the existing state of the body, which makes all the difference between salutary and morbid results. The amount of a remedy, which had been curative in one case, may, in the same dose in another case nearly analogous, or if not exactly applied, lead to a fatal issue. This is seen in the different results of the principal agent before us in its common operation upon every individual, according as the vesicant may be duly prepared, or covered with dry cantharides, or wet with a saturated tincture of the same.

In the long journey which I have thus far traveled, I have been extensively employed in seeking out the provisions which the Author of Nature has so bountifully, however intricately, ordained for the relief of those principal diseases of mankind, fever and inflammation. And yet we have often had occasion to see that many of the most valuable agents for these purposes are directly productive of inflammation when unskillfully applied. This is often exemplified by many of the cathartics; and the Peruvian bark, and its analogous tonic associates, will relatively cure or exasperate intermittent fever, according to the exact conditions under which they are administered. We have seen, indeed, that even wine, brandy, &c., now and then become remedies for fever, and even for inflammation (§ 752, &c., 892 *g*, *p*). The apparent contradictions I have endeavored to reconcile, and to show that the occasional coincidence in the results of agents which are opposed to each other under ordinary circumstances is due to a common law which governs the operation of all causes upon organic life. The causes operate upon those properties in which life fundamentally consists, and thus give rise to healthy, or morbid, or curative effects, just as they happen to affect those properties (§ 137 *d*, 150, 151, 177, 189 *b*, 350½, 350¾, 369 *a*, 638, 852 *a*). In disease, as we have seen, their susceptibility is variously altered from the natural standard, and variously so in any given disease, as in fevers and inflammations; according to the numerous fundamental and transient circumstances already set forth. It may be, therefore, that, in a few cases of *common* inflammation, bark or wine will place the diseased conditions in as favorable a state for the recuperative efforts of Nature, as bloodletting and cathartics will do it in most other instances; and when either produce this auspicious change, they are antiphlogistics. It is upon this principle, therefore (or that of the general tendency of a vast range of therapeutical agents to establish salutary changes in febrile and inflammatory disease, when duly employed), that I have assembled the most useful part of the Materia Medica under the general denomination of Antiphlogistics.

The foregoing remarks are preliminary to a farther exposition of the same principles which are concerned in the therapeutical operation of the group of agents upon which we have now entered, and which are curative by exciting inflammation, or analogous conditions; and the best of them are such as will effect, in a given time, the nearest approach to a full development in the skin of the most simple form of *common* inflammation (§ 721, 722, 729 *a*). These means are, prin-

cipally, cantharides, issues, and setons. Their immediate action is strictly morbific; and they have no salutary effect upon existing inflammations till they produce a corresponding disease, or, at least, that morbid irritation which forms the access of inflammation, in some part of the surface of the body. Then it is that this artificial inflammation or irritation so modifies the natural one, that the latter may subside, rapidly, without any other curative influence; while the artificial one is so peculiarly constituted by the nature of the remote cause, that that, too, readily takes on a disposition to subside, and thus the patient escapes from the inflictions both of Nature and of art (§ 133 *c*, 137 *e*, 150, 151, 639 *a*, 852, 853, 854 *c*, *d*, *e*, 858, 905 *a*).

893, *d*. It has appeared to me a matter of no little importance to consider the foregoing facts and the philosophy which concerns them; since, in connection with what has hitherto been said of the operation of internal agents, and connected with what is yet in prospect relative to the special influences of loss of blood, they open widely a view of the great principles of solidism and vitalism, and of the stupendous laws by which healthy and morbid processes are carried on, and illustrate that connecting medium between them which is constituted by the various gradations of the restorative movements as instituted by remedial agents under the great recuperative law of organic beings. The whole is but an intimate chain of analogies from the most perfectly healthy state to the gravest conditions of disease (§ 901).

We see, also, distinctly exemplified, by the mode in which blisters, setons, &c., produce their favorable results, that absolute remedies institute the process of cure in virtue of their morbific qualities; and this becomes the more striking when we associate with the alterative influences of vesicants upon internal inflammations, through the artificial disease which is established in the skin, those natural cutaneous inflammations, as erysipelas, &c., that are subdued by the direct contact of the vesicant with the inflamed surface.

893, *e*. We may now pause, for a moment, to observe how clearly the various effects of cantharides prove the operation of curative agents, either by a direct action upon the organic properties of a diseased part to which they may be applied, or through the instrumentality of the nervous power when they extend their therapeutical sway to distant organs, and how, also, the nervous power is variously modified, and variously directed upon remote parts, according to the nature of its exciting causes (§ 227, 228, 230, 233$\frac{3}{4}$, 497, 500). The common mode in which cantharides, setons, moxa, scalding water, burns, &c., relieve or increase deep-seated inflammations, or disturb the system at large, is clearly manifest; and since only one of the foregoing agents is liable to absorption, every precept in philosophy divests the coincident effects of cantharides of a shadow of possibility that they are due to an absorption of the agent. We have seen, too, how erysipelas may be removed by the direct action of cantharides upon the part inflamed; and this (especially when associated with the remote effects of all other remedial agents) assures us, as a next link in the demonstration, that a modification is imparted to the nervous power, according to the special virtue of the remote cause, which operates, in that particular instance, upon the remote part in a mode corresponding more or less with that which is observed in the primary action. And now if we look at what is often going forward in the blad-

der, we shall see yet farther (something for the senses, something for "experimental philosophy") that the nervous power actually acquires the virtue of an inflammatory agent, and analogous, too, to the specific characteristic of that virtue as it appertains to cantharides. Now carry this to those inflammations which are constantly springing up in different parts as consequences of each other, in the natural round of disease, and you will come with me to the conclusion that the same philosophy obtains throughout.

It may not be assumed that the morbific action of cantharides upon the bladder is the result of absorption, since, if all its other remote influences are conducted through the nervous power, it would be a discreditable violation of the simplicity of causes, to assign such a medley for the same phenomenon. But, what settles conclusively the fallacy of the doctrine of absorption, is the fact that the bladder is never irritated by cantharides, applied to the skin, until it establishes some manifest influence upon this organ, however long it may remain upon the surface; and, I may add, that, when the cutaneous irritation takes place, the cuticle remains equally as at first a medium of prevention, so far as this construction may obtain. It is the same as we have seen of tartarized antimony, in gradually-increased doses, when the manifestations of its remote influences often keep pace with the amount of effect exerted upon the stomach.

But, though the cantharides supply an apt illustration of the whole philosophy of our subject, and, like the natural developments of inflammation which follow each other as sympathetic consequences, denote a modification of the nervous power in great conformity with the nature of the causes by which it is brought into operation, there is, nevertheless, a great variety of remedial agents, which, in their therapeutical doses, manifest no action upon the organ to which they are applied, and through which they overcome disease in parts remotely situated; as also other important ones, like mercury, when applied to the skin. And, although it be rendered obvious by the morbific effects of these agents that they modify the nervous power in their therapeutical aspects as much according to the nature of the several agents, respectively, as do cantharides, issues, setons, or as when one natural inflammation supervenes upon another, I have made the qualification which is due to a subject hitherto so entirely unexplained, that the modifications of the nervous power take place *under the influence of its own nature* (§ 228, *a*).

Finally, in respect to the modus operandi of cantharides, when considered in its analogies to other vesicants, issues, &c., we have an interesting view of the specific relations which the special virtues of certain remedial agents sustain toward the modified irritability of particular parts of the organism, and a proof, also, of the diversified conditions of irritability in different parts, and of the remarkable manner in which the nervous power is directed with salutary or morbific effect through certain motor nerves by the peculiarities of each exciting and modifying cause (§ 233$\frac{3}{4}$, 500 *g*), while there is simultaneously presented by the operation of cantharides a curative influence upon all parts that are affected by disease, and a morbific one upon a special part that was antecedently in its natural state (§ 150, 151, 188 *a*, 190 *a*).

893, *f*. From what has been now said, it is manifest that vesicants,

issues, setons, and other counter-irritants do not produce their favorable effects through the discharges to which they give rise; though this is one of the principal interpretations in the humoral pathology. The effusion instituted by cantharides is so unimportant that it can scarcely be taken into the account in explaining the curative influences of this agent (§ 863). Moreover, it frequently happens that blisters afford all the relief of which they are capable by acting merely as rubefacients. This, indeed, is oftener true than is commonly supposed, since vesicants are generally permitted to remain till vesication is established; though in numerous cases this extent of their action is unnecessary.

Since, therefore, cantharides will often answer its intention when employed only as a rubefacient, and operates at all times through the vital impressions it exerts upon the skin, it may appear unimportant to some whether this or another agent be employed for the purpose of counter-irritation. Such, indeed, is, unfortunately, supposed to be true by many practitioners, who resort to mustard cataplasms, or ammonia, &c., where cantharides would be a far more useful agent. So true is this, where active inflammation affects any of the important viscera, and vesication has become appropriate, and may be of the highest importance, the rubefacients, which operate speedily, have little or no salutary effect, and are often detrimental, by increasing constitutional irritation (§ 150, 151).

893, *g*. The foregoing remarkable difference in results (*f*) is owing, in part, to the difference in the virtues of the remedies, and, in part, to the difference in time occupied by the several agents respectively. In all cases of very rapid irritation of the surface, vesication, &c., whether induced by ammoniated lotions, mustard, boiling water, moxa, &c., the curative effect upon deep-seated inflammations is far less than where the artificial disease is more slowly instituted. It is, nevertheless, of no little moment, in the case of vesicants applied for active forms of disease, that the irritation of the skin should advance with considerable rapidity, and that vesication should ensue, at adult age, in from six to twelve hours. That is the most useful period; and when the full action of cantharides is longer delayed, whether by some defect in the remedy, or by a subdued irritability of the skin, the curative effect is commonly less obvious.

It is also proper to observe, in a philosophical as well as practical sense, that time has various influences, according to the modification of disease, its seat, its duration, the constitution, sex, age of the subject, &c.

But, in no respect is the influence of time so remarkable as seen in the difference of results in the treatment of acute and chronic diseases; in which respect counter-irritation is on a par with other remedial influences. When inflammation is recent, the usual rapidity with which cantharides operates is best suited to almost all forms of the disease; but when it has run into a chronic state, and has become the subject of habit, it frequently happens that tardy suppurants, such as setons, issues, tartar emetic ointment, &c., are highly useful (§ 535, &c.). Yet there is no doubt that the difference in results as it respects the time of these cutaneous agents, in the acute and chronic forms of inflammation, has been often much overrated; especially the advantage of a suppurating surface in chronic diseases. It is apt to be supposed, in

these cases, that there is something to be discharged, either "concocted matter," or such as refuses to be concocted.

893, *h*. Although it be true that chronic inflammations oppose to counter-irritants the obstinacy of morbid habit, and naturally suggest the long-continued and uninterrupted influence of issues, &c., experience has fully shown, that, in most cases of low indolent inflammations, they are surpassed by a frequent succession of blisters. This experience, too, has mostly banished from use the savine ointment, and other agents, which were but lately and largely employed to maintain the action instituted by cantharides. The difference goes, with an endless variety of analogous facts, in illustrating some of the profound problems of organic life. The uninterrupted action of issues, the prolonged ulceration of vesicated surfaces, &c., are more or less apt to establish a morbid habit peculiar to the modifying agents; and, although it be a first step in the series of changes which are necessary to establish the full recuperative process, the pace is retarded by the habit induced. To break this force of habit, it is only necessary to intermit the agent during the time required by the healing of a blister. The curative impression remains, and the irritability of the organ diseased undergoes an increased susceptibility to the agent at its successive renewals. Each repetition gains upon the last, and often presents the aspect of cumulative influence. The principle is shown in relation to many things, and may be seen in the action of antimony, opium, &c., in former sections (§ 550–556, 558 *b*, 889 *m*).

The influence of habit of which I have now spoken, as it respects the artificial change induced in chronic inflammations by the uninterrupted operation of issues, &c., grows out of the analogous habit which the agent establishes in the artificial or curative disease, which soon lapses into that chronic state which is less and less sensibly felt by parts morbidly affected; while those parts, and the entire system, are gradually accommodating themselves to the artificial irritation, and by which this irritation loses still farther its sympathetic and curative influences upon the morbid conditions for which it is instituted. But if, on the contrary, a succession of irritations be employed, the habit of which I have spoken is neither established in respect to the system, nor the parts diseased, nor in respect to the artificial condition; but every successive repetition of the irritation produces nearly as profound an impression as the first (§ 150, 151). Here, too, along with the coincident effects of numerous internal agents, we may call up the advantages of repeated leeching, as presented in a subsequent section (§ 926).

The same great principles are concerned in all the cases. An elegant philosophy obtains throughout; and, although founded upon the great Institutions of Organic Nature, it is surrounded by so many of the qualifying circumstances that are incident to the instability of the vital properties, it can be fully appreciated and converted to the high practical purposes of which it is susceptible, only by a careful, impartial, and unremitting attention to the phenomena of organic beings.

893, *i*. The principles to which I have just adverted (§ 893, *h*) lie at the foundation of other practical facts connected with the success of counter-irritation. The impression upon the skin, for instance, must be carried to a certain intensity, and that will depend upon the nature and force of disease, and other obvious contingencies. If it be

slight, the necessary impression may not have been made; while, on the other hand, if in excess, then it may disturb not only the general functions of the body, but aggravate the inflammation which it is the design of the remedy to relieve. In this respect, therefore, there is a close analogy with the action of remedies, when administered internally, as it respects their doses.

Another important point to be observed is the extent of the surface over which an artificial irritation should be established. This will manifestly depend upon a variety of circumstances; upon the nature of the irritant, upon the extent, force, and situation of the disease, &c. If the usual agent, cantharides, be employed, and the surface irritated be of narrow limits, it may be insufficient to break in upon the morbid process, however intense may be the artificial irritation. On the other hand, however, if a very large surface be irritated, its sympathetic influence may be morbific, although the artificial irritation be not intense. The difference in effects is of the same nature as that which attends the small, deep burn of moxa and an extensive superficial scald; the former being of no importance, while the latter may be speedily fatal.

But, there is a great difference between the effects of an extensive surface vesicated by cantharides, and by scalding water; and this probably arises mostly from the difference in the times which the remedies occupy. In the former case, the system is gradually accustomed to the sympathetic influences, and may be but little disturbed, while, in the latter, the violence of the impression upon the system is proportioned to its instantaneousness; and the extent of the surface irritated being great, a violent shock is the consequence. In other words, the nervous power is developed in great intensity, with great suddenness, and prostrates, at once, the energies of organic life beyond their recuperative nature (§ 150, 151, 228 *b*, 479, 509).

It is evident, therefore, that there is only a certain parallel between the effects of vesication by cantharides and scalding water, whether upon a small or an extensive surface,—scarcely exceeding the partial coincidence by which I have endeavored to illustrate the difference between small and large vesications by cantharides, and to expound again the principles concerned in the effects of agents which operate gradually or with great rapidity. The difference, indeed, is so great between the effects of vesication when the gradual result of cantharides, and those which are instantly induced by scalding water, that we may safely vesicate an extent of surface by the former agent which it might be fatal to attempt by the latter (§ 891, *m*). The tincture of cantharides, when applied to the skin, produces vesication with great rapidity, is far less curative, and oftener disturbs the constitution, than when vesication over the same extent of surface is produced by the common plaster.

Nevertheless, there are certain inflammations, especially of a neuralgic and rheumatic character, and not affecting important organs, in which a rapid and violent irritation of a very small surface, as by moxa, will sometimes overcome the disease. But these intense, sudden, and limited irritations, in affections of any of the important viscera, are never useful.

If the disease be of a different character from inflammation, as the suddenly painful affections of the stomach that are incident to indiges-

tion, or, as in colic, &c., the rapid irritation which is produced by the rubefacients may then afford immediate relief, and more effectually than might be yielded by the vesicating action of cantharides. These rubefacients are, also, often abundantly efficacious in the declining stages of articular rheumatism, or in low chronic states of that disease. But this is a peculiar modification of inflammation which will also yield, under the same circumstances, to some internal remedies which exert no salutary influence upon the common, or other modifications of inflammation.

893, *k*. The vesicating plaster is generally made too small to yield all the benefit of which it is capable. Four inches square is a common size for the thorax and abdomen; while six or eight inches square are not only equally safe, but far more efficient, under the ordinary circumstances which justify or require this remedy. Indeed, so comparatively safe is it to institute an extensive irritation by means of cantharides, when the state of the system is properly prepared, and the force of disease is otherwise moderated, and so important is it in certain conditions of disease to effect a very powerful impression, especially in the cerebral inflammations that refuse to yield to copious abstractions of blood, that I have sometimes rescued patients by the apparently desperate practice of vesicating simultaneously the entire scalp and a large extent of surface upon the neck and shoulders. Where bloodletting has been thoroughly practiced, and inflammation remains obstinately seated in some great vital organ, a blister of twelve inches square will sometimes speedily extinguish the disease, when one of six inches would be insufficient.

But, in respect to inflammation of the brain, it should be distinctly understood that vesication of the scalp is entirely inadmissible, unless the irritability, and therefore the susceptibility, arising from the morbid state, be greatly lessened by abstractions of blood, cathartics, &c. The irritation of the scalp will be otherwise propagated with morbific effect upon the brain; which arises, in this instance, partly through continuous sympathy along the communicating vessels (§ 498). Nor is it expedient to incur the risk when immediate danger is not impending, but to apply the agent to the neck and shoulders. The same objection lies against the application of blisters to the immediate vicinity of the eyes and ligaments in their very irritable states of inflammation. But if, in these cases, the disease have lost its activity, or be of a chronic nature, the vesicant is then most efficient when applied near to the part affected. It sometimes happens, however, in chronic conditions, that the skin in the immediate vicinity becomes sympathetically affected through the same influences from the parts beneath as are propagated upon them, at other times, by vesicating the overlaying skin. These morbid states of the adjacent surface are generally obscurely marked; though sometimes abundantly apparent, as in active forms of articular rheumatism. The obscure conditions often become strongly pronounced by an irritative, erysipelatous inflammation which is set up by vesicants, and by leech-bites, and which commonly aggravate for the existing time the natural disease; though the morbific influence is apt to disappear, and leave the disease as it was, as soon as the artificial irritations subside.

893, *l*. It may be now said, as a general rule, that the liability of counter-irritants, when applied near to a part inflamed, to increase the

inflammation, is in proportion to the intensity of the disease, the intensity of the artificial irritation, and the rapidity with which it is produced. It may, therefore, be regarded as safe, in a general sense, to apply vesicants and rubefacients immediately over the affected parts in chronic inflammations. But this is far from being true of moxa, where the affected part is in the vicinity of the surface.

And yet we have seen that it may be sometimes perfectly safe and useful to place an epispastic in direct contact with certain inflammatory states of the surface. This, however, is never true of common inflammation of the skin, and only so of a few specific varieties. Even erysipelas has been successfully treated in this manner; which opens to us another illustration of the principles upon which remedial agents operate. The disease, being a specific modification of inflammation, has not the disposition to subside spontaneously which belongs to common inflammation. The remedial agent, therefore, varies the mode of inflammation, and thus introduces a modification in which the properties of life are brought into recuperative action. But, it is otherwise with common inflammation, since the virtues of cantharides are such as to aggravate this condition when brought into immediate contact with the part affected. The same explanation applies to the therapeutical effect of the spirits of turpentine, when applied to a burn or a scalded surface; since, in these cases, the inflammatory state is turned from the common standard, and admits of the institution, by other irritants, of modifications more favorable to the recuperative process.

893, *m*. With the qualifications now made, it is obvious from what has been said of the modus operandi of counter-irritants, that they will be curative in proportion as they are applied to the vicinity of the seat of disease. Their salutary effects, like their morbific, depend more upon this approximation than upon any special sympathetic relations between certain parts of the surface and the particular internal organs; since it is mostly by contiguous sympathy that these agents produce their curative effects (§ 497).

It is also a remarkable fact, that it appears to be of no great moment in what particular tissue of compound organs the disease is seated. Inflammations of either are alike affected by irritants as they are by loss of blood; but varying, in all the cases, according to the general vital constitution of the several parts (§ 150, 151).

893, *n*. We have seen that it is the tendency of inflammation to limit itself to the tissue which it invades, and that its extension to other tissues of the same organ, or to other parts, is by remote or by contiguous sympathy (§ 497, 498). It is also particularly true of certain tissues that they are apt to extend the violence of their remote influences upon parts of similar organization; especially in specific forms of inflammation. Thus, rheumatic inflammation of the ligaments is very apt to invade the pericardium, and sometimes the dura mater; and, the peculiar inflammation which constitutes the mumps (cynanche parotidea), often involves the testes or the mammæ. There is much reason to think, in the former case, where the heart so often participates, that the inflammation is first propagated to the pericardium, and subsequently from that organ to the serous tissue of the heart (§ 141, 525–529). In the latter case, or that of the mumps, the affection of the parotid will frequently subside when the other glands become af-

fected; and the disease is then said to have undergone a metastasis, or to have been virtually translated from one part to another. Articular rheumatism affords constant examples of this phenomenon, in its rapid and successive invasions of different joints, and the frequency with which it subsides in one as it springs up in another.

Now, there is a prevailing error in the pathological construction of this extension and subsidence of the disease, which has led to a very common error in practice. It is supposed that there is a translation of the disease from one part to another, an actual movement of the complaint —something, probably, after the manner of the gases, as represented in a former section (§ 350½, *n*). The phenomenon, in consequence, has long borne the significant name of *metastasis;* and if gout happen to go from the foot to the stomach, it wanders so much out of its way that it gets in the stomach the well-known and expressive name of *misplaced gout.* As all men, therefore, are greatly moved in their practical habits by theoretical views (§ 4), it is no less common to imagine that the rheumatic or gouty affection may be driven or invited back to its appropriate place. Hence the applications which are made to the primary seat of the affection, but from which disease has taken its departure. And so, also, counter-irritants are applied to the parotid gland, should the testes, or mammæ, become affected in mumps, in the expectation of calling back the disease which is so far astray.

In the first place, however, there is, in all these cases, nothing concerned but the ordinary operation of sympathy, and nothing is wanted to render the treatment appropriate and intelligible but a knowledge of physiology and pathology. All the ambiguous results are directly referable to the laws which govern the operation of the nervous power, which now presents itself in the compound aspect of a morbific and remedial agent among parts which have either strong natural relations, or which are especially susceptible of morbific influences that result in the condition which is the supposed subject of translation from one part to another; while, in its turn, the sympathetic disease propagates, after the manner of vesicants, curative impressions upon the primary seat of the disease.

Secondly, the artificial irritation excited with a view to recalling the disease (as in vesicating the joints when gout attacks the stomach, and this, too, even when that organ may be the primary and only seat of the affection) is very different from the modification of inflammation which constitutes the pathological state of the disease itself, and therefore would not become, by any reflected influence upon the parts beneath, a substitute for it; while it is certainly an anti-pathological mode of recalling the specific, or any form of inflammatory disease, in deep-seated parts, since counter-irritation is one of the principal means by which we remove inflammation of these parts.

The foregoing practice, as founded upon the doctrines of metastasis and revulsion, is not only contra-indicated by physiological laws, but by all experience. The practice has been wholly directed by hypothesis, and has not been sustained by any favorable results. We need go no farther in proof of this than the admitted failure of M. Louis, in his application of "blisters to the legs," to remove, upon the foregoing hypothesis, the gravest forms of inflammation and disorganization of the brain, intestine, liver, &c., which befell the victims of "The Typhoid Affection" at La Charité. And here we see again exemplified

in the extensive sway which may be exercised not only by the authority of a favorite writer, but in the pernicious tendency of conclusions in medicine that are founded upon the results of practice as directed by errors in principles, the proneness of man to rest his inquiries, his hopes, his reputation, the happiness and the lives of mankind, upon simple views of the most abstruse, stupendous, and comprehensive Institutions in Nature,—the Institutions of organic life (§ 4, $5\frac{1}{4}$, $5\frac{1}{2}$, 349 *d*, $350\frac{1}{4}$–$350\frac{3}{4}$). But, let us have an example in relation to vesication to counter-irritation by cantharides, as propounded by the great head of the Necroscopic School. Thus:

"*Blisters*," says M. Louis, "*ought to be banished* from the treatment of the typhoid affection." "If they exercised any influence upon the duration of the disease in the patients who have recovered, it was by *prolonging* it a little."

Again. "I have not only *rejected vesication* from the treatment of *pneumonitis*; I have also ceased to employ it in *pleurisy* and *pericarditis*." "How can we believe that the effect of a blister is to check an inflammation, when this blister is one inflammation superadded to another?"! "In thoracic inflammations, their usefulness is neither strictly demonstrated (according to the *numerical method*), *nor even* probable."

"One thing is *most assuredly beyond question*, and we should never be weary of repeating it: that the *therapeutic value of blisters is not known*; that it must be studied by the aid of *numerous* and carefully-noted facts, *just as if nothing at all were known about it*."

If the reader be not conversant with the history of that kind of "experimental philosophy" upon which the foregoing conclusions are founded, or with the efforts which are in progress to give it an ascendency over the philosophy which Nature teaches, he may obtain some knowledge of their extent by referring to foregoing sections (§ $5\frac{1}{2}$ *a*, 349 *d*, $350\frac{3}{4}$ *kk*. Also, *Med. and Physiolog. Comm.*, *Essay on the Writings of M. Louis*, vol. ii.).

Instead, therefore, of the unavailing efforts of applying blisters to the extremities for the relief of cerebral, or hepatic, or intestinal, inflammation, &c., let them be directed to the organs which are the seats of disease, by applying them over, or in the vicinity of, their respective regions.

As to the doctrines of metastasis and revulsion, which have had their origin in the phenomena of the laws of sympathy (especially as witnessed in the successive development and subsidence of disease as they obtain in gout, rheumatism, and mumps), the whole system is constantly supplying examples of the accession of one disease as the sympathetic consequence of another, and the subsequent decline of the primary affection as a sympathetic result of the secondary development. And here, by-the-way, we are presented, in the natural process, with a perfect exemplification of the principle upon which counter-irritants operate in subduing diseases remote from the seat of their application; and we may thus readily comprehend how it happens that the discharge from an ulcer, or a seton, or blister, &c., will be suddenly arrested, or the superficial parts turned into the worst conditions, by the occurrence of disease in some internal part.

The foregoing play of sympathies, however, is far from being equally true of all organs, or of all forms of disease. It is most distinct-

ly pronounced where pulmonary phthisis is preceded by gastric derangement, when the occurrence of the former often takes the lead and relieves, for awhile, the latter affection; but only again to light up indigestion, and ulcerative inflammation in the intestinal mucous tissue (§ 803, 804). But, it is rare, perhaps never, that remote diseases are favorably impressed by any form of disease that may happen in the alimentary canal. On the contrary, indeed, all such conditions never fail to aggravate or to maintain any affections that may be remotely situated.

Nevertheless, such is the analogy between the sympathetic influences of diseased parts,—between the rise and decline of diseases, in certain parts, as consequences of each other, and the curative effects of many internal agents, that a vast number of therapeutists, overlooking the relations of the alimentary canal to all other parts, confound these internal remedies with the external counter-irritants; classing them all under the name of revulsives or counter-irritants. And here is opened another wide door to an excessive abuse of violent internal agents, and where we may well contrast the ten-grain alterative dose of tartarized antimony, and the most powerfully-irritating cathartics, administered with a view of establishing counter-irritation in the stomach and intestine, with that prejudice against bloodletting, which sees nothing of the counter-irritant in the effects of this remedy. And how well does not all this submission to theory admonish us of the importance of investigating the nature of the influences which are effected by loss of blood (§ 4)! We all know what is doing in the way of tartar emetic. But let us take an example of the same philosophy from among the cathartics; for this is the only way of helping the cause of humanity in such cases, or of arresting another evil (§ 878) upon a more selfish principle. Let us go to the erudite and ablest work on Materia Medica for an example; and we will have others respecting certain substitutes for bloodletting in a future section (§ 960). Thus, then, Pereira:

"Pliny truly observes that the juice of the *elaterium* apple is dangerous when applied to the eye; and Dr. Clutterbuck mentions that some of it 'getting accidentally into the eye in one instance, it occasioned severe pain and inflammation, with an erysipelatous swelling of the eyelids, that continued the following day.' We have a farther proof of its irritant properties in the inflammation and ulceration of the fingers of those employed in its preparation. When swallowed, therefore, *elaterium* irritates the gastro-intestinal membrane, and occasions vomiting and violent purging." "In some dropsical cases, I have known a single dose discharge several pints of fluid from the bowels. The gripings, and the increased number of evacuations, prove that the irritation is not confined to the mucous coat, but is extended to the muscular coat. Under the influence of a full dose, the pulse is excited, the tongue becomes dry, and sometimes furred, and great thirst is produced. Considered with respect to other cathartics, we find it *pre-eminently* distinguished by the *violence* of its purgative effect."—Pereira's *Materia Medica.*

And yet is this cathartic commended above all other *hydrogogues* for the cure of dropsy; and even boldly so, upon the principle of its producing *counter-irritation* in the gastro-intestinal mucous tissue; that is to say, the same sort of inflammation which affects the fingers

when the juice is applied to the skin. It should be also said of so valuable a work as that from which the foregoing extract is made,—valuable as a system of *Materia Medica*,—that Pereira approves the practice, and of course, therefore, the principle. The principle is thus stated by the author:

"Its effects," he says, "in dropsy, are two-fold; first, absorption of the effused fluid; secondly, the stoppage of any farther effusion in consequence of the *metastasis* of vital action from the seat of the dropsy to the intestinal membrane."

And again, he says, "In apoplectic affections, elaterium, as a drastic cathartic, sometimes proves serviceable on the principle of *counter-irritation.*

That is the doctrine. A metastasis of the inflammation to the intestinal canal; and such is the virtual effect. The reader will readily supply corresponding examples, and, as he meditates upon the philosophy and its bearings upon mankind, he may come to the conclusion, if not already in the way, that some practical advantages may yet accrue to the world from a knowledge of the modus operandi of remedial agents (§ 904 *c*, 960).

Opposed to metastasis, revulsion, counter-irritation, &c., is the doctrine of *repulsion.* Thus, in respect to the utility of vesicating the joints in acute forms of rheumatism and gout, there is a strong array of opposite opinions. The objections to the practice are founded upon the same pathological conclusions that have led to the cultivation of ulcers, cutaneous eruptions, &c.; it being supposed that it is often the effect of counter-irritants to repel (as it is called) the disease from the joints, and to establish it upon the heart, the stomach, or other important organs. This supposed effect, therefore, is exactly the reverse of that which I have just considered, or the induction of disease to sound parts by counter-irritation. In one case, the advocates of metastasis suppose that they invite disease from one part to another not diseased; in the other they are employed in driving disease from the affected part to another part not affected.

That is the modus operandi. But, its fallacy is shown, at once, by the flitting character of gout and rheumatism; suddenly subsiding in particular joints and as suddenly invading others, or attacking the internal viscera, when counter-irritants are not employed. Indeed, it is now known that inflammation of the tissues about the heart is a very common attendant of articular rheumatism; and the fact that acute gout is, at present, rarely treated by vesication, yet as frequently as ever invades important organs, disproves the assumption as to the tendency of blisters to produce these results. But, I am not advocating the employment of counter-irritation in acute forms of rheumatism and gout; certainly not till the intensity of disease is greatly subdued by antiphlogistics of a sedative nature.

In connection with the last remark, it is also worthy of observation, that free bloodletting, in acute rheumatism, is strongly opposed, upon the ground of its tendency to involve the heart in rheumatic inflammation. But, in all the reputed cases, the inflammation had probably already affected the heart before the abstraction of blood, and constituted cases for a very extensive application of the remedy. If loss of blood will more speedily surmount the disease in any other part than the united force of all other means, it cannot, surely, fail of a corresponding effect upon the main source of the circulation.

893, *o*. Among the evil consequences of vesication is a bad condition of cutaneous inflammation, which either refuses to subside, and annoys the patient by its excessive irritation, or it results in extensive ulceration, or in gangrene. These conditions are owing to a very morbid state of the skin, generally consequent on some formidable disease affecting the great viscera of the abdomen; especially the gastro-intestinal mucous tissue (§ 698, *l*). They add, of course, greatly to the evils of the disease, and hasten a fatal termination, which is apt to ensue upon the disease itself. These effects of blisters are most frequently witnessed in scarlatina, and often along with swollen, and ulcerated, or sphacelating, fauces. But, happily, they are rather rare; certainly less frequent than is surmised by many. It is never possible to know the existence of the peculiar condition of the skin which gives rise to these consequences; no more so than we are able to infer the predisposition to erysipelas which is often established by abdominal affections (§ 698, *l*). From their rarity, also, an apprehension of their possible occurrence should never deter us from the use of blisters.

Strangury is another, and a frequent evil of cantharides, though it do not often seriously exasperate the disease. The urinary bladder has no strong physiological relations beyond its own system of organs, and pain is not apt to prove morbific, of itself (§ 140, 422, 891 *m*). There is no way of preventing its occurrence in particular subjects with any certainty.

893, *p*. The foregoing are the most obvious injuries which are produced by vesicants, especially by cantharides (§ 893, *o*). These unfavorable results, indeed, are commonly regarded as the principal ones to which the common epispastic is liable. But, there are others, which, though too often neglected, are far more important, since they are frequent, and often determine a fatal issue of disease. These evils arise from morbific influences which are propagated abroad either by too intense an irritation of the skin, or from creating the irritation under unfavorable circumstances.

It is the last condition which is the most frequent cause of the unfavorable effects of blisters, and which, in the hands of superficial observers, have led to the denunciation of this important antiphlogistic.

The inauspicious states for vesication depend, especially, upon too exalted irritability of the parts diseased, or of other organs; particularly of the heart and general circulatory system. If blisters, or other counter-irritants, be applied to the skin in this state of morbid irritability, the diseased parts are roused to a greater intensity of morbid action, and the whole vascular system to a more violent movement; so that a series of untoward results is thus instituted, which sympathetically, and mutually, aggravate each other, and give rise to new morbid developments, till the multiplying circles of sympathy may be arrested only by their own fatal tendency. Nor can I doubt that many of those terrible inflammations, and structural lesions of all organs, which abound in M. Louis' work on the *Typhoid Affection*, and which have been taken as the basis of the most important principles in pathology and therapeutics, were owing to the cause now under consideration; since this distinguished man was about as hostile to bloodletting as he became toward vesication, after witnessing its fearful effects in the complicated malady which will be long celebrated in the annals of medicine.

The system, in the advanced stages of fever, is generally in an irritable state, is oppressed with local congestions and inflammations; or, whether so or not, the artificial irritant becomes a source of annoyance, and often adds to the dangers it was intended to avert. This, indeed, is especially the time when such useless local irritations should be avoided, or quieted if they exist. Remaining inflammations and congestions should be treated with as little additional disturbance to the system at large as may be possible in those advanced stages of fever which were the subjects of Louis' experiments, and of too many others. Or, if it be necessary to resort to counter-irritants for their removal, they should be, at least, applied in the vicinity of the affected organs, where, alone, they can be of any avail.

Independently, therefore, of the direct and immense advantages of bloodletting, cathartics, antimonials, &c., we realize more sensibly the force of their importance, in acute inflammations, at least, when we consider that without the antecedent aid of one or another, but of bloodletting especially, we are completely cut off from the benefits of counter-irritation. Nay, more; so great are the prejudices against the principal remedy for inflammation and fever, or so sparing is its application, that cathartics inflict many evils when they might otherwise be rendered highly salutary, or their necessity, as well as of epispastics, superseded.

In all grave inflammations loss of blood is indispensable to the most useful effects of cathartics, or to their safety, and is absolutely the only condition under which counter-irritation should be attempted. Just as long, also, as the disease may remain in force, or general or local abstractions of blood may continue to be useful, vesication should be delayed. This remedy may then succeed with the most happy effect upon any remaining disease, even though it have passed into some other form than that of inflammation.

In the chronic states of inflammation, whether of important or unimportant parts, a frequent renewal of blisters will effectually surmount many obstinate maladies. But here, again, these agents are often powerless, though not as mischievous as in acute inflammation, till decisive bloodletting have been adopted, and, not unfrequently, often repeated. This is every day witnessed in those advanced stages of indigestion, where a low chronic gastritis, denoted by tenderness over the region of the stomach, and where, too, the liver has generally become more or less involved in morbid action. Vesication will not reach this condition, till general bloodletting or leeching shall have been duly premised; and cases are not uncommon, where, after repeated and large abstractions of blood, such is the force of morbid habit, that the disease finally issues in copious hæmatemesis. There are, also, many of the fluctuating states of the stomach in chronic indigestion, where no inflammation has invaded the stomach, in which blisters over the epigastric region, and without any other remedial agent, bestow great relief. The appetite and digestion are at once improved, and the patient started along upon the road to health, and placed in a state for the full and rapid influence of change of air, exercise, &c. The analogy, too, in these cases, with the useful effects of tonics and stimulants in others, contributes farther light upon the therapeutical influences of the latter remedies (§ 890½). Again, among the sequelæ of fevers is constantly before us a variety of phases of indigestion in which vesi-

cation of the epigastric and hepatic regions brings great relief to the sufferer, when this remedy is properly sustained by a well-regulated diet, and other salubrious habits.

893, *q*. There are numerous remedies, besides those which have been under consideration, that operate more or less upon the principle of counter-irritation, and yet exert an alterative action peculiar to each. This is even true to a certain extent of leeching; the irritation of the bites, and even the new action which is instituted in the capillaries of the skin by the leeches, being analogous to the irritative process which is set up by the true counter-irritants (§ 498).

But there are great modifications, in these respects, between the local influences of leeching, and the effects of the true counter-irritants; and, if we now turn our attention to the large group of agents under the denomination of *local alteratives*, as set forth in my Materia Medica, we shall see, that, in all the instances, each substance has an alterative action peculiar to itself; while, in many of the cases, as with iodine, the mercurial plaster, veratria, camphor, &c., there are associated influences analogous to those which form the great characteristic of the true counter-irritants. These, however, will of course depend upon the amount of absolute irritation which the several agents may produce in the skin; some, as gum ammoniac plaster, proving a very positive irritant, and affording relief to chronic inflammation of the joints more in virtue of this counter-irritation than of alterative properties peculiar to the agent.

That common principles, however modified in their general aspect, and however varied in the details relative to the several agents, respectively, are concerned in the principal results, is obvious from the fundamental simplicity of organic laws, and especially so from occasional coincidences in the curative effects of all the agents now under consideration. We see, for example, in cases of indolent tumors, chronic enlargements of the liver, spleen, &c., that almost any one of these local alteratives will sometimes yield complete relief. We see it following the application of either leeches, or blisters, or ammonia, or mercury, or iodine, or even of simple friction, &c.; and, if we next regard the corresponding effects of many internal remedies for the same conditions of disease, we shall not fail to detect a coincident and harmonious philosophy throughout.

In connection with the foregoing subject, it may be useful to some who may be baffled in their attempts upon indolent tumors of low inflammatory growth, to know the advantages that have often accrued to myself from the frequent application of a small number of leeches. Where they may refuse to yield under this mode of treatment, vesicants, or iodine, &c., may ultimately prove efficient, when they might have been powerless without the antecedent influences of leeching. The tumors, indeed, may not apparently have yielded in the least to the virtues of the leech; but this remedy will have placed the diseased part in a state of susceptibility to the action of other agents. The principle has been variously before us (§ 556, *c*), and may receive another exemplification in the frequent necessity of general bloodletting and cathartics to the salutary effects of vesication, in the treatment of acute inflammation (§ 137 *d*, 150, 151).

893, *r*. In all hemorrhages from important organs, we should regard vesication as a remedy next in importance to the general and local ab-

straction of blood, if the latter be also appropriate, as it commonly is in the early stage of the disease; and when, at more advanced periods, Nature takes on this recuperative effort, vesication is the principal remaining means by which we may contribute an aid that timely blood-letting would have greatly surpassed, and would have given to art what ultimately belongs to Nature (§ 805)

SUMMARY REVIEW OF THE GENERAL PHILOSOPHY OF THE MODUS OPERANDI OF REMEDIAL AGENTS.

"It seems to me that the explanation which represents Nature always pursuing a uniform course in her operations, drawing the same results from the same principles, has a greater degree of probability than that which shows her separating, as it were, this phenomenon from all the others, in the way which she produces it."—BICHAT.

"Medicines differ from poisons, not in their nature, but in their dose."—LINNÆUS.

"NATURA MALUM SENTIENS GESTITAT MAGNOPERE MEDERI."—GALEN.

"NATURA REPUGNANTE, NIHIL PROFICIT MEDICINA."—CELSUS.

"NATURA DEFICIENTE, QUICQUAM OBTINET MEDICA ARS, PERIT ÆGER."—HIPPOCRATES.

894, *a*. THE philosophy which concerns the operation of morbific and remedial agents was a subject of consideration in the first two volumes of the *Medical and Physiological Commentaries*, and subsequently in an Essay which contributes to the third volume of that work. The question has been also presented, incidentally, in different parts of these Institutes. But, it is a part of the plan of the present work that its consummation shall consist of a distinct exposition of the important matter now before us, in the form of a summary review of the relative facts and doctrines contained in former sections.

894, *b*. In approaching, again, the *modus operandi of remedial agents*, I may first repeat the most essential points,—that the vital principle is a real substantive agent, of which the vital properties, irritability, mobility, &c., are elements, superadded to organic beings after the creation of their structure; that the nervous power was superadded only to the animal kingdom; that all organic functions are carried on, through their instruments of action, by the four vital properties which are common to all animated beings; that all vital agents, whether stimulant or sedative, whether natural, morbific, or remedial, operate directly upon these properties, when the nervous power is not concerned in developing motion or changes; that all disease consists in a modification of these properties and a consequent change of function, and is therefore only a variation of the natural states; that the vital property sensibility possesses a modification which I have denominated sympathetic sensibility; that the nervous power is a vital agent, and, like other agents, develops motion and induces changes by acting upon the organic property irritability, and is exclusively the exciting cause of motion in animal life; that this power or property of the vital principle in animals may be called, in a direct manner, into increased, or preternatural, operation by direct impressions, physical or moral, upon the nervous centres, or upon the trunks of nerves; that this power is the efficient agent of remote sympathy, is brought into operation by impressions made upon sympathetic sensibility, which are transmitted by this property of animal life, through sensitive nerves, to the nervous centres, and there develop the nervous power, which is reflected, through motor nerves, upon the irritability of such parts as may be determined by the various influences hitherto expounded, and thus become the exciting cause of motion, of morbific or therapeutical

changes, &c., in those parts upon which its impressions are made; that the nervous power is susceptible of modifications by the causes which bring it into universal operation, whether physical or moral, and thus partakes, *under the influence of its own nature*, of the special virtues of each exciting cause, to which principle is due its alterative effects according to the nature of the exciting causes; and, finally, that a common principle is at the foundation of the philosophy, whether the manifestations of the nervous power be displayed in maintaining the concerted action of the healthy organism, or in deranging that action, or in restoring disordered movements, or as the power may be concerned in developing motion, voluntary or involuntary, when propagated immediately from the nervous centres, and without, of course, the intervention of sensitive nerves.

895. These several fundamental points have been critically presented in former sections (now too numerous for special reference), and they have all an immediate interest in the operation of remedies. They form the great principles which concern the natural operation of vital stimuli, and are, therefore, fundamental in the production and cure of disease. The plan of Nature is thus perfectly simple, consistent, and sublimely beautiful, in its foundation. The details are distinguished for their harmonious variety and intricacy, yet susceptible of the most complete analysis. We trace the complexities to the constitutional nature of the organic properties,—to their liability to multitudinous variations from their natural state,—to the various natural modifications which they sustain in different tissues and organs,—to the variety of those organs, and the differences in their respective functions,—to their intricate connections and dependences by means of sympathy,—and to the endless variety in the nature of the virtues of foreign agents which are capable of inducing modifications of the organic states of every part, and according to the nature of each agent.

Such are the great points to be kept in mind; but most of all, as it regards my present inquiry, are the various considerations relative to the nervous power, and the laws of sympathy, as hitherto set forth, and through which I interpret all the influences produced by morbific and remedial agents upon parts that are remote or but slightly distinct from the direct seat of their operation, and often, in part, upon their direct seat of action, unless such influences are propagated by continuous sympathy.

896. The whole philosophy of the operation of morbific and remedial agents rests, as we have seen, upon physiological principles. Exactly the same philosophy relates, also, to the corresponding effects of moral causes. The wound, or the poison, or the errhine, which convulses the muscles, the want of air which determines respiration, the impression of light which guides the motion of the iris, the irritation of fæces or of urine which maintains a contraction of the sphincters, the food which excites the muscular action of the stomach or the contraction of the pylorus, the cathartic which purges, the emetic which vomits, the narcotic which arrests diarrhœa, or allays irritability, or induces sleep, the gastric stimulant or the remote inflammation which rouses the sanguiferous system, or the sedative which prostrates the circulation, or as one or another may destroy life, produce their effects through a common law which is relative to the nervous power, and it is through that same law that the complex organization

moves on in harmony in all its parts, that the mind brings into action the voluntary muscles, that syncope is removed by pungent vapors, or by a current of air, or by a dash of water, that cold to the surface determines the first inspiration of the new-born being, that warmth to the skin instantly rouses all the processes of life in certain prostrating conditions of disease, that cold at the zero of Fahrenheit, or mechanical irritation, reanimates the torpid hibernating animal, and sends up his temperature from forty or less to near a hundred degrees, that the first contact of solid food with the stomach diffuses a warmth over the cold surface of the famished traveler, or that tonics and stimulants do the same, that shame or anger suffuses the countenance, or fear withdraws the blood from the circumference to the centre and bathes the skin in perspiration or renders the urine redundant and the bladder irritable, that cold, when suddenly applied, as suddenly increases the excretion of urine, or the hot bath determines, as suddenly, its expulsion, that offensive odors, offensive sights, and even their recollection, lead to instant vomiting, or to purging, or to syncope, that an hour's change from one part of the town to another suspends pertussis or promotes digestion or the healing of an ulcer, that one passion cures the most obstinate maladies, or another is instantly fatal,—each, and all, I say, determine their effects through one common law which is relative to the nervous power. Anatomy and experiment confirm what each phenomenon, and all united, proclaim the work of that mystic power, operating on those organic properties which are the moving springs of every action, the proximate cause of every effect; nor can another intelligible solution be rendered for a single phenomenon now expressed, or thousands of similar import, while every other must be in conflict with the pronunciations of Nature and the demonstrations of art. Nor will an attempt be made (an attempt that shall commend itself to the understanding) now, or hereafter, to controvert the philosophy which is here presented. The first step in its overthrow must be the overthrow of Nature. All must bow to this conclusion, however unacceptable to the humoralist, or unpalatable to the materialist.

897. It has been seen, also, that the fundamental philosophy of disease is perfectly simple, as also that which concerns its cure; that disease is essentially nothing more than a deviation of the properties of life from their natural standard, and a consequent corresponding change in the functions over which they preside; that the artificial cure consists in a restoration of those properties and functions by making upon the former certain impressions which enable them to obey their natural tendency to a state of health; that remedial agents of positive virtues operate like the truly morbific, but less profoundly in their therapeutical doses, and that the philosophy of their cure consists in establishing, in a direct manner, certain morbid alterations in the already diseased properties and actions of life which are more conducive to the natural tendency that exists in the vital properties to return from morbid to their natural states.

898. It follows, therefore, when disease subsides under the influence of remedial agents, that it is only in consequence of the great law of recuperation, which is brought into sensible operation by the production of morbid states which are favorable to its development. But, if disease terminate fatally, it is owing either to morbid altera-

tions which transcend the recuperative tendency, or to physical obstacles which have resulted from the altered vital conditions. If disease subside without the intervention of art, it arises from the operation alone of that natural principle which has been established for the preservation of health, and the perpetuation of organic beings. Of this we have remarkable and striking examples in small-pox, measles, &c. For wise purposes, as we have seen, a principle of mutability has been established in the properties of life, and it is through this principle, which is designed for useful ends in the animal economy, that they are liable to be variously altered from their natural state by physical and moral causes ; but it is this very principle which enables them to receive salutary impressions from remedial agents (just as they do from morbific), and to return to their natural condition.

899. The changes, therefore, to which the properties of life are liable, are almost of endless variety ; depending, as we have variously seen, upon the nature of the operating causes, habits, natural and acquired temperaments, age, sex, &c. ; and whenever they become diseased, they pass through a variety of progressive changes till they reach the acme of their morbid states. And so, on the other hand, when remedial agents begin their operation, a series of other changes sets in, and continues in regular progress until it ends in health. The pathological conditions, therefore, of any given disease are constantly varying, and may require frequent variations of treatment.

900. It being only necessary to establish a peculiar morbid change in diseased conditions that shall favor the operation of the natural tendency of the properties and actions of life to return to their healthy state, a very few remedial agents may be all that are requisite to the attainment of that result; while experience shows that our materia medica is encumbered with superfluities. Take a large variety of pathological conditions, such, for example, as are presented by inflammation, it is not necessary that a certain uniform change should be established by the remedies, but only such as shall favor the recuperative tendency. Bloodletting brings about one kind of change, cathartics another, antimony another, mercury another, and so on ; while each of these agents may prove perfectly curative in many cases of all the modifications to which inflammation is liable from absolute morbific agents. And yet it is obvious that each one produces changes peculiar to itself, while the changes induced by either will be as various as the natural modifications of disease (§ 756, *a*). And just so it is in respect to the great variety of remedies which will tend to the cure of intermittent fever. This disease will sometimes yield to almost every thing in the materia medica, and may be suddenly broken up by an emotion of the mind. But every agent exerts changes in the morbid properties of life peculiar to itself, but such changes as enable the properties and actions of life to pass, afterward, through a succession of spontaneous changes under the restorative principle, till they end in health. There is no other philosophy that will account for any of these phenomena, while they all concur in demonstrating its foundation in nature. Hence, also, I may add, what I have already endeavored to expound, the occasional salutary effects of alcoholic stimulants in the treatment of fever, and acute inflammations, and through which, in part, I have attempted to abolish the distinction between active and passive inflammation. In these exam-

ples, the alcoholic stimulants do but introduce morbid conditions that are favorable to the recuperative process, and are, therefore, so far on a par with loss of blood.

901. Nevertheless, a distinction is very properly made into curative and morbific agents, however the former may be productive of disease, as they commonly are, in their medicinal doses, when they do not correspond with the existing pathological conditions. Their absolute mode of action, however, is the same in all the cases; and although, in a general sense, remedial agents exert their salutary effects by inducing new pathological states, and are generally liable to produce disease when exhibited in health, these morbid states, when not excessive, are of a nature to allow the full exercise of the recuperative tendency. On the contrary, however, there is a class of agents which are more profoundly morbific, and whose results transcend the natural recuperative process. It is for the removal of these consequences that we employ the other class of morbific agents. Or, there are yet other means, like exercise, air, &c., whose influences are of the mildest alterative nature, and appear to co-operate in a direct manner with a tendency to restoration which had already begun; or, as in hooping-cough, where the restorative process is often easily introduced. Our remedies, therefore, are curative by substituting new pathological conditions, and nature does the rest; and it is only with a view to a right interpretation of their *modus medendi* that I have any disposition to depart from established phraseology, or to confound the operation of remedies with that of the ordinary causes of disease (§ 893, *c*, *d*).

That what I have now stated as to the substitution of one pathological state for another, in the cure of disease, and that this is the only contribution which nature receives from art, seems to be abundantly obvious; though the proposition which I have thus made appears not to have been rightly apprehended by all. As a change arises when efficient agents operate, and as that change, by the supposition, is not a restoration of the morbid to the natural state, it is necessarily a new pathological condition. And so, also, of the unaided changes which Nature institutes, till the natural state is fully established. Bloodletting, and emetics, it is true, will be sometimes followed, as in pleurisy and croup, by an almost immediate subsidence of the symptoms; but, during their rapid operation, they have only introduced new conditions of the pathological states which enable the morbid properties to resume, at once, a near approximation to their healthy standard. It is certain that art can accomplish nothing more.

902, *a*. I now proceed to recapitulate the manner in which remedial agents produce their effects upon parts remotely situated from the direct seat of their application; and this, as I have formerly said, is through remote, continuous, or contiguous sympathy; the agents exerting their direct impression upon the parts with which they are in contact. Remote, and probably, also, contiguous sympathy, are conducted by the nervous power through the medium of the cerebro-spinal and ganglionic systems; while, as I have also endeavored to show, continuous sympathy is independent of the nerves. When, however, these enter into the structure of parts, as in animals, they have a certain contingent participation. But their primary connections may be wholly severed, and disease may be yet propagated continuously along the

part to which they appertained; as we observe, also, in plants. I appears, therefore, that in these examples, the morbid condition is extended, in a continuous manner, from the organic properties of one point to the next in apposition.

902, *b.* I have variously shown that the nervous power is capable of acting as a vital stimulus to the organic properties, is liable to be variously developed by morbific and remedial agents, and to be so modified in its nature according to the virtues of such agents, that it produces, more or less, in diseased parts, remote from the direct seat of the morbific or remedial action, the changes which the agents themselves would exert were they applied directly to the remote organs. The nervous power may be, also, equally determined with a morbific or curative effect upon the organic properties and actions of the great nervous centre; or upon any of its radiating parts. The philosophy is also exactly the same when one diseased part gives rise to disease in parts that are remote; and when disease in remote parts, that has been maintained by affections of other parts, subsides in consequence of the restoration of the latter, it is owing to the removal of a pernicious modification of the nervous power that had been constantly propagated by means of the latter upon the former.

902, *c.* The type of the foregoing philosophy exists in various processes which are naturally going forward in the animal body. A single example of this nature is a key to the whole labyrinth. Thus:

"The whole system of respiratory nerves can be excited to action by irritation of any part of the mucous membrane, from the mouth to the anus, from the nostrils to the lungs."

Mechanical irritation alone is adequate to the greatest variety of effect, as broadly stated in the foregoing law of sympathy. Tickling the fauces provokes vomiting, irritating the anus produces purging, and thus are the muscles concerned in respiration, and those of the stomach and intestine, and even the liver and the salivary glands, brought into unusual action by slight mechanical irritation of the fauces or anus. Irritate the same tissue in the nose, and the respiratory muscles are thrown into another mode of action; irritate the larynx, and another mode is excited; call up the recollection of the finger in the fauces, and the mind may determine all the sensible results of an active emetic.

There is the great principle. It is greatly the work of the nervous power, excited in one series of the cases by impressions transmitted from distant parts to the nervous centres, and in the other by the direct operation of the mind upon the same central parts. It is through that principle that emetics and cathartics produce their most sensible manifestations, and the same is concerned in all their less obvious influences upon every part but the intestinal mucous tissue, except as continuous sympathy may contribute a part of the influences which extend to the liver, &c. It is the same as concerns the respiratory movements, which, as I have said, may be regarded as an elementary exemplification of the most entangled operations of the nervous power. The modus operandi may be repeated in its exemplifying relations to this subject. The point of departure, in the process, is the mucous tissue of the lungs, from which the impression is transmitted through the pneumogastric nerve, as well as through the ganglionic, to the brain and spinal cord (especially the medulla oblongata), where

the nervous power is excited and reflected upon the organic properties of the muscles of respiration, through the various motor nerves of those organs. These muscles are, in consequence, thrown into action, and the thorax expanded (§ 233$\frac{3}{4}$, 500 *e*, 514 *l*, &c.).

If the foregoing simple, demonstrable exemplification be duly comprehended, there can be no difficulty with all the rest. In the example of sneezing, as a consequence of the action of light upon the eyes (§ 514, *l*), the process is more complex, and shadows forth the far more intricate movements that are in progress,—the almost endless circles of sympathy which are taking place,—during the progress or decline of disease, or those which are set up by the operation of an emetic, a cathartic, &c.

902, *d*. Physiological examples of the foregoing nature abound in the animal organization, and supply the most ample ground for the interpretation of the effects of remedial and morbific agents in their wide range of influences. The modifications of the circles of sympathy which relate to the respiratory system alone, as in coughing, crying, laughing, yawning, &c., are a fruitful field of inquiry into great and precise laws, and extensively applicable to the philosophy of medicine. The only difference is, that, when disease is established in a part, or when remedial agents operate, the organic properties of the part are altered in their nature, and, of course, the organic actions over which they preside. A specific impression, in the latter cases, is transmitted to the cerebro-spinal axis, the nervous power more or less modified in a corresponding manner, and from thence reflected through other nerves, or other fibres, to the same or other parts, and, according to the nature of the modification, disease will be produced or mitigated in those parts. However complex, and variable, therefore, the phenomena, nothing can be more simple than the principle through which all these changes are produced.

902, *e*. When an emetic operates, the modus operandi is essentially similar to what happens in respiration. The mucous tissue of the stomach being the point of departure, a different influence is propagated to the nervous centres, corresponding with the nature of the exciting cause, with the special vital constitution of that portion of the mucous tissue, with the compound nature of the stomach, with the special relations of this organ to the central parts of the nervous system and to the respiratory muscles, &c. (§ 138, 149, 150, &c.), while the nervous power is also modified in its nature according to the peculiar virtues of the emetic (§ 227). The most sensible result, as in respiration, depends upon the reflection of the nervous power upon the respiratory muscles, while another current descends through the motor fibres of the pneumogastric and sympathetic nerves to the muscular tissue of the stomach. If the emetic operate also as a cathartic, then a new chain of actions is established, in the same way, upon the abdominal muscles, while a current of the nervous power is propagated upon the muscular coat of the intestines (§ 233$\frac{3}{4}$).

902, *f*. But, in the foregoing case, something more happens than in the natural processes. Here the exciting cause possesses peculiar virtues, is of a morbific nature, and it not only makes peculiar impressions upon the alimentary mucous tissue, according to the exact nature of its virtues, but it modifies the nervous power in a corresponding manner. If the stomach be the seat of disease, the direct impres-

sion upon that organ, or the change which an emetic may effect in its vital condition, will be more or less varied from what is exerted in a state of health. It may, therefore, prove curative to the stomach more or less by this direct influence (§ 514 *b*, 658). But the nervous power is also modified according to the impression produced upon the organic properties of the stomach, and is sent abroad, with alterative effect, upon various parts of the system. According to a law by which diseased parts are far more susceptible of influences from vital stimuli than such as are not diseased, the modified nervous power will fall with far greater effect upon the former than the latter. The organic properties and actions of one may be profoundly and permanently affected, while the latter are only moderately and very temporarily influenced. In consequence, also, of the deep effect which the modified nervous power exerts on the diseased parts, they may return, at once, to their natural state (§ 841).

But the milder influences which are set up by the nervous power upon parts in health, or in comparative exemption from disease, play, also, their part in the salutary process. If the emetic operate also as a cathartic, impressions are transmitted from the intestinal mucous membrane to the cerebro-spinal system, the nervous power developed and modified according to the nature of these impressions, and radiated abroad as when the result of the action of the emetic upon the stomach, and with effects corresponding to this new development and modification of the nervous power.

Again, the skin is influenced in the foregoing manner, and this organ transmits that impression to the cerebro-spinal axis, and develops and modifies the nervous power accordingly, when it is, as in the other instance, reflected abroad, and is felt by various parts according to their degrees of susceptibility. Various other circles of sympathy of the same nature set in, and become too complex for analysis; but all may fall with one concurring curative effect upon the diseased susceptible organs. Thus every part may have an allotment in the curative process; as more distinctly expounded in foregoing sections (§ 143, *c, and references*).

902, *g*. We thus see that when vomiting springs from the operation of tartarized antimony, and often from ipecacuanha, it is only one of the consequences, and a minor one, of the peculiar irritation of the gastro-mucous membrane. Other and far more powerful influences are determined, simultaneously, upon the organic properties and actions of distant and diseased parts (perhaps as distant as the most remote extremity), by the same nervous power that shook the respiratory organs during the act of vomiting. And often, indeed, does it happen that those influences are propagated with the most profound effect, when the act of vomiting fails of being consummated; and nausea, alone, shall send with prostrating effect the modified nervous power over the whole system; when we shall see it simultaneously bathing the whole surface with perspiration; pouring the saliva from the mouth; breaking down a tumultuous excitement of the heart and arteries; starting on the instant a torrent of bile, and an equal effusion from the intestinal mucous membrane; and, at the next moment, calling up a magnificent play of sympathies for the evacuation of the fluids, after the manner of an active purgative,—these very effusions, also, instituting other circles of sympathy, which join in the great

work of curative movements. Should vomiting now follow, then shall you speedily see the vital energies returning,—the cold, pale skin giving place to a florid hue and a warm perspiration,—the sunken features starting into the fullness of health,—the gastric suffering gone as a luxury obtained,—the general whirl of anxiety and distress converted into calm tranquillity,—the headache dissipated,—the twang of the croup, or the grunt of pneumonia, no longer sounding an alarm;—and, all this stupendous succession of events, from the beginning of nausea to the restoration of the vital energies and the near resolution of disease,—composing a most astonishing consecutive series of sympathies,—may require less time than I have hastily employed in this general allusion to the subject. And now can it be entertained that this has been the result of absorption, or that the laws of chemistry or physics have had any connection with the phenomena?

902, *h.* The foregoing may be taken as an example of the principle which concerns the *modus operandi* of all curative or morbific agents, whether physical or moral, and of all the developments of disease that arise as sympathetic consequences of each other. In respect to emetics, however, it should be considered that all do not produce the foregoing effects, and that with the exception of the act of vomiting, the results will depend upon the precise nature of the emetic, or the manner in which it modifies the nervous power and thus impresses the organic properties. This explains the difference in results between tartarized antimony, ipecacuanha, sulphate of zinc, warm water, tickling the fauces, the mechanical irritation of undigested food, the shock of a fall, of a surgical operation, sailing, whirling, offensive sights, offensive odors, loss of blood, and even their recollection; while the nature and effect of the greater number should lead the philosophical inquirer to pause at the physical doctrine of absorption, and survey the other difficulties with which it is fatally encumbered.

902, *i.* When the alterations, of a sympathetic nature, are more slowly produced, as when mercury gradually induces salivation, and brings the whole system under its influence, or when small, and repeated doses of tartarized antimony overcome inflammations of the lungs, &c., the nervous power is developed and modified at each successive dose, and the repetition of its influence upon the organic properties of diseased parts remote from the stomach establishes progressive changes, till an absolute condition of disease may be induced in certain parts, as when mercury salivates; while the analogous influences which are exerted on parts already diseased supplant the naturally morbid states by others of an artificial nature, from which the organic properties are able to return to their healthy condition. But these impressions must be frequently repeated; for if the interval be long between the administration of the doses of such agents as only produce their effects in a gradual manner, the diseased conditions, not being placed in the way of the recuperative tendency, will throw off the artificial impression, and the original intensity of disease will be thus restored. The process which I am now considering is an example of the *cumulative* effect of remedial agents, some of which are much more remarkable than others, and the ultimate results are pronounced with varying degrees of suddenness. This is also influenced by peculiarities of constitution, or of susceptibilities of the organic properties to changes now under consideration; and therefore is it, that sal-

ivation may be speedily induced in one subject by less than a grain of calomel, while no amount of the remedy will produce this effect in others. And so of the morbific effects of digitalis; an agent, also, which exemplifies the instantaneousness with which alteratives may produce an explosion of disease, although no symptoms had admonished us of its approach. This principle concerns, also, the predisposition to disease which is formed by miasmata, the virus of small-pox, of hydrophobia, &c.

902, *k*. The permanent operation of the nervous power in particular parts of the animal fabric, as in the sphincters, supplies an elegant parallel with the foregoing uninterrupted influences of the same power as developed by remedial or morbific agents. This power operates as a perpetual stimulus to the organic properties of the muscles just mentioned, in the same way as blood does to the heart and capillary arteries. And now, if we mutilate the inferior part of the spinal cord, or observe the sphincter ani when relaxed in bad cases of apoplexy, or regard its condition when the spinal cord is merely divided, we shall see the relative bearing upon other organs of these two parts of the nervous system in their connected state, but with injury of the brain, and how the spinal cord is capable of an independent influence (§ 473–475, 476½–481, &c., 514 *g*, &c.).

902, *l*. When moral causes operate in the cure, or production of disease, they act directly upon the cerebro-spinal axis, and develop and modify the nervous power according to the nature of each mental affection; and, as in the case of physical agents, the nervous power thus developed and modified may be determined as well upon the organic properties of the brain and spinal cord, as upon other parts. The blow upon the region of the stomach, or the opening of a thecal abscess, which have destroyed life on the instant, operate in the same way as the paroxysms of anger, or of joy, which have been as suddenly fatal. In these cases the nervous power is first determined with a fatal effect upon the organic properties of the nervous centre.

902, *m*. A more intricate example may now be presented relative to those natural means of cure which occur in a former section; such as change of air, exercise, &c. (§ 855). These are all positive remedies, and, of course, they have their modes of operating. One example will open the philosophy of the whole. How, then, does change of air suddenly arrest an obstinate form of the hooping-cough? There is gastric as well as pulmonary disease, and the mucous tissue of the stomach is preternaturally susceptible to the influence of many causes. The air exerts its impression upon the lungs, and upon the general surface of the body. But, there must be other agencies in operation before the lungs will experience relief. These agencies appertain to the nervous power, which is developed by the foregoing impressions, and reflected upon the stomach and other abdominal organs. If there be disease here, it is more or less relieved, and the more so, the greater will be the ultimate salutary impression upon the lungs. The abdominal impression is transmitted to the nervous centres and the nervous power reflected with its alterative influence upon the pulmonary mucous tissue, and thus ends the disease. The spasmodic action of the respiratory muscles is, of course, arrested by withdrawing the preternatural operation of the nervous power from those muscles, as a consequence of the subsidence of disease in the pulmonary mucous

tissue (§ 902, *e*). And so, when change of air promotes the healing of ulcers upon the extremities; and should they not be complicated with derangement of the abdominal organs, one of the sure evidences that the foregoing is the modus operandi of this remedy is the improvement of appetite which commonly precedes any manifest abatement of the remote affections. The same philosophy applies, also, to the control which air and exercise frequently obtain over phthisis pulmonalis (§ 514 *c*, 525 *c*, 527 *b*). It is conspicuously seen even in the operation of morbific causes; and the two aspects of the subject go to illustrate each other (§ 657, *a*). The principle is of the utmost importance in medicine. Its laws are precise. Their knowledge will lead to a greater dependence upon the curative efforts of Nature (§ 878, 905 *b*, 905½ *b*).

903. It is important to consider the distinction between impressions which are made, in organic life, upon *irritability* and *sensibility*, by vital agents, whether natural, morbific, or remedial. The latter property is the subject of impressions particularly in animal life; though it becomes more or less involved in organic, in all its natural modifications, by the accidents of disease. But the special modification which I have considered under the name of *sympathetic sensibility*, performs the important part of transmitting impressions to the nervous centres when they give rise to sympathetic movements in organic life. Indeed, the whole rhythmic action of the organism is maintained by the transmission of influences from all parts to the brain and spinal cord through this modification of sensibility, and a consequent determination of the nervous power upon all the organs, as each may require the harmonizing influence of this great regulating property of the vital principle (§ 233¾).

The foregoing is the only agency which sensibility exerts in organic life, and the nervous power no other than that of a vital agent, acting, like other agents, upon *irritability*, from which the influence is imparted to *mobility*. This we have also seen to be equally the case in animal life, when voluntary motion is performed. In all the cases, however, where *perception* is excited, either *common* or *specific sensibility* is more or less interested, though neither modification takes any part in the organic or animal movements.

If the brain, or any part of the nervous system, be the seat of disease, of irritation, &c., the preternatural development of the nervous power is, as we have seen, *direct*, and propagated *directly*, and with very various effects, upon distant parts. In this process the motor nerves are alone concerned, and therefore sympathetic sensibility is not brought into operation. It is exactly the second part of the process which takes place when influences are transmitted from one organ to another through the medium of the nervous centres. There is, therefore, no difference in the principle. The experiments of Wilson Philip, &c., illustrate the *direct* method (§ 477, &c.); the constitutional action of remedies the *indirect*.

904, *a*. In considering the philosophy of the effects of the nervous power, it is important to regard its nature as liable to modifications from the slightest influences, both physical and moral. This is evinced by all the phenomena, is analogous to the natural and artificial modifications of irritability and sensibility; and according to its modifications, and other concurring causes hitherto expounded, it produces

changes in the organic properties and functions; establishing or removing disease, or killing in an instant.

I say, therefore, again and again, as more deeply seated than all things else at the foundation of medical philosophy, the nervous power is not only variously excited, exalted, or depressed, or modified in its kind, and produces influences upon remote parts according to these changes, but it is reflected upon particular parts according to their existing susceptibilities, the nature of the remote cause, and the part upon which the remote cause may operate (§ 233¾). Thus, as I have said, one impression from cold, as a blast of cold air, or a drop of cold water upon the skin, will rouse the respiratory muscles. Another impression from the same cause will excite catarrh, or pneumonia, or pulmonary phthisis, or articular rheumatism (§ 649 *b–d*, 657, &c.). Mercurial ointment will determine the nervous power specially upon the salivary glands, and liver, and the same effects arise from the action of mercury upon the stomach. Cantharides, internally or externally applied, irritates the neck of the bladder. One degree of impression by tartarized antimony upon the stomach determines the nervous power upon the respiratory muscles, and vomiting is the consequence; while it simultaneously reflects the same power upon the skin, as it does in smaller doses, and of which perspiration is a consequence,—and so on. But these examples embrace only certain parts of the influences in each case; while in others, they are far more complex,—one sympathetic result becoming the cause of others, till, through a single impression upon the organic properties of the skin, various circles of morbific or remedial sympathies may be instituted. Narcotics induce peculiar modifications of the nervous power when they are administered by the stomach, and the power thus modified is not only reflected upon various distant parts with effects corresponding with its modifications, but especially, also, upon the organic and animal properties of the brain and spinal cord. Hence the obtuseness of the senses, and the venous congestions of the brain, which follow their improper administration.

904, *b*. We have seen that hydrocyanic acid, strychnia, &c., will destroy life, when applied to the tongue, before one act of inspiration can be made, and that the odor of the acid, when swallowed by man in speedily fatal doses, is indistinguishable in the blood, or within the organism (§ 350½ *p*, 827 *d*). Wedemeyer and Müller testify to the fatal effect of one drop of the hydrocyanic acid, within a single second, when introduced into *the eye* of a rabbit. And so of strychnia. It is also allowed by Müller, who defends the doctrine of absorption in all cases, that from a minute to two minutes are necessary to the absorption of all other substances. The case is a plain one; the contradiction obvious (§ 494, *dd*). Besides, the action of these poisons must begin at the instant of their contact with the living parts, and what is progressive throughout the entire second of time is physiologically the same as at the beginning of the second. Magendie kills "the most vigorous dogs" by applying to the fauces one drop of the hydrocyanic acid, "after two or three hurried inspirations." Pereira says that he "once caused the *instantaneous* death of a rabbit by applying its nose to a receiver filled with the vapor of the pure acid. The animal was killed without the least struggle." And so did Magendie. Pereira adds, that in cases of this nature, "the rapid action of the poisons seems

almost incompatible with the idea of their absorption."—PEREIRA's *Mat. Med.*, p. 27, 242. The experiments by Stilling and Van Deen settle the question as to absorption (§ 494). Consider the action of opium. Apply it to the mucous tissue of the intestine, and the local impression is such that it immediately arrests the peristaltic movements. Apply it to the surface of the brain, and it instantly lessens the action of the heart and capillary blood-vessels, &c. Now combine these phenomena, when opium exerts its direct action upon the stomach, and indirectly upon the heart, capillary system, &c., and consider the natural relations between the stomach and nervous centres. Take a substantial, physical fact, as supplied by the advocates of absorption. Thus:

"It is very singular," says Sigmond, "that a pill of opium, administered by the stomach at night, will be *vomited up* in the morning, *after having produced its narcotic effect.* This is an observation which Van Swieten originally made."—SIGMOND's *Lectures*, &c.

The doctrine of sympathy which I have propounded clears up the obscurity, and admits of the only explanation (§ 512, *b*).

"I am acquainted with a physician in London," says Sigmond, "who, on taking opium, although in a very minute quantity, will have over the surface of the body a scarlet efflorescence" (§ 891, *e*).—*Ibid.*

Is not this phenomenon due to the same principle as that which is concerned when indigestible food occasions analogous eruptions, or when they spring up, as in infancy especially, from gastric and intestinal derangements, or when the blotches of a surfeit vanish during the operation of an emetic, or as croup disappears under the same influence? Turn to the experiments of Philip, Alston, Hall, Stilling, Buniva, Van Deen, Kreimer, Procter, Girtanner, Johnson, &c., and they will be found to confirm my conclusion (§ 399, 483, Exp. 21, 484, 485, 826 *b*).*

The following are other facts which demonstrate the local operation of remedial and morbific agents, and the dependence of their constitutional effects upon the laws of sympathy. Thus:

"An *imponderable* quantity of atropia," says Pereira, "is sufficient, when applied to the eye, to cause dilatation of the pupil."

Now consider the effect of this "imponderable quantity" in connection with the analogous effect of imponderable light (§ 514, *k*), and the modus operandi of the latter will be found to coincide with that of the former. The cases are remarkably parallel, and the more interesting as showing the transmission of influences through sympathet-

* In connection with what I have incidentally said in a former section of the advantages of opium in the cerebral congestion which is induced by the intemperate use of alcoholic liquors, and which constitutes a prominent part of delirium a potu (§ 891, *r*), I may say that we witness here, in the manner in which the irritability of the nervous tissues is relieved, and the subsidence of disease as a consequence, not only the special modification of irritability, according to the nature of the remote cause, but also the special adaptation as a remedial agent of what is morbific in cerebral congestions as induced by any other cause (§ 150, 151, 191, 650, 662, 686 *b*).

But, although a knowledge of the remote causes aid us greatly in the treatment of disease, we may not proceed upon this consideration alone, as is commonly done, more empyrically, in delirium a potu. Opium rarely fails of being pernicious, in that affection, if there be much gastric or hepatic derangement, until this condition be more or less overcome. It is always useful to premise a cathartic, of which calomel should generally form a component part; and, in many cases, bloodletting is an indispensable remedy. But here, again, the exact pathology, and the complications of the disease, should be well ascertained, or bloodletting may prove as pernicious in some, as opium does in others.

There are also certain states of the brain attendant on maniacs in which opium is beneficial; but we must be sure of the right, or we shall be sure to go wrong.

ic sensibility as pronounced in an expanded nerve and as implanted in the skin of the eyelid, or in the tunica conjunctiva, and therefore through different sensitive nerves, while in all the cases, the motor nerve and the part which is impressed by the nervous power, are exactly the same (§ 233¾). It is also worthy of remark, as exemplifying the modification of the nervous power by preternatural agents, that the motion of the iris is very different under the different influences of the remote causes (§ 74 *a*, 188½ *d*, 514, *l*).

"It is a very interesting fact," says Sigmond, "that the application of hyoscyamus and belladonna to the eye was not applied to any practical purpose until a gentleman by accident applied a piece of the herb to his eye, when the effect remained for *three weeks*."

He states, also, that a dilatation of the pupils may be produced by only approximating the leaves of hyoscyamus or belladonna to the eyes. This is a closer parallel with the effect of light than the preceding statement by Pereira.

Observe how many individuals are liable to violent erysipelatous inflammation over the whole surface of the body, from approaching only within a few yards of several species of rhus; while, on the other hand, many are entirely insusceptible of its action, as many are of the constitutional effects of mercury (§ 585, *b*).

Here, again, is another fact, coincident with the foregoing, and which also elegantly illustrates the different natural modifications of the organic properties; even in different parts of the same continuous tissue (§ 133, &c.). "As an enema," says Sigmond (I quote from the advocates of absorption), "hyoscyamus, in any quantity, cannot be given." Authorities are quoted to show that it then produces delirium, and even apoplectic symptoms, in doses that are inoffensive when administered by the stomach.

The snuff which regales the nose, and the tobacco which equally delights the mouth, are violent poisons to the intestinal mucous tissue; and the constitutional results harmonize with the local effects in either case (§ 133, &c., 150, 151). Again, if remedial or poisonous substances act by absorption, why is tobacco smoke so innoxious when inhaled by the lungs, and yet so deleterious when swallowed, or when conveyed into the rectum? Most remedial agents, indeed, produce constitutional effects according to the natural vital modifications not only of the mucous, and other tissues of different parts, but of one continuous tissue, as the mucous membrane of the eyes, nose, fauces, œsophagus, stomach, small and large intestines, larynx, trachea, and lungs. Where would philosophy be; where our interpretation of these various consequences, if we followed the chemist in his physical views of life? What would tobacco affect in such a case? Would it nauseate by affecting chemical affinity, or cohesion, or elasticity, or would the nose or the mouth enjoy through any such properties of matter,—or would galvanism help our understanding? Is it through any such properties that we feel the smart when the fire burns? Does not Pereira supply an important fact against his general doctrine of operation by absorption when he defends a moderate practice of opium smoking,—especially as the whole volume of smoke is drawn into the lungs?—(*Mat. Med.*, p. 1293.) Shall we not rather look to what is known of the natural modifications of irritability in the mucous tissue of different organs? If opium offend the stomach, the principle is the

same as when urine excoriates the mucous membrane of the lungs, and thus produces the most violent constitutional effects. But the distinguished author above quoted shall lay down our principle himself. Thus:

"Sir B. Brodie," he says, "found that an infusion of tobacco, thrown into the rectum, paralyzed the heart, and caused death in a few minutes. But if the head of the animal be previously removed, and artificial respiration kept up, the heart remains unaffected; proving that tobacco disorders this organ through the medium of the nervous system only" (§ 484, *b*).—*Ibid.*, p. 869.

Should we not rather say, through the medium of the brain in its connection with the spinal marrow, while other parts may be sympathetically affected through the spinal marrow, or even the ganglionic system alone. And now contrast with the foregoing peculiarities of tobacco and opium, the fact that the inhalation of the fumes of hyoscyamus produces vertigo, tremors, laborious respiration, &c.; and that hydrocyanic acid, in the quantity of a drop, or in vapor, on account of the coincident relations of its virtues to the naturally modified organic properties of various parts, is instantly fatal, whether applied to the mucous tissue of the eyes, nose, mouth, stomach, or lungs. And so of the spirituous extract of nux vomica. If absorption be good in some of the cases, it should be equally so in the others. Consider, too, how the habitual use of narcotics reduces the susceptibility of the stomach to the influence of each one, respectively, and not to the others, and how the constitutional effects go on, *pari passu*, in the ratio of the local effects. And consider, also, how music assuages suffering, or the expectation of the dentist relieves toothache. And why, according to the doctrine of absorption, should not medicines produce the same constitutional effects when injected into the bladder, as when administered by the stomach? Are you doubtful as to the manner in which certain substances produce their constitutional effects, when applied to the skin, as mercury and tobacco, for example? Consider the foregoing case of hydrocyanic acid; or how an issue relieves deep-seated inflammation; or, again, how belladonna, or hyoscyamus, when applied to the lids of the eyes, as when to the stomach, produces dilatation of the pupils.

Again, let us observe the constitutional effects of tartarized antimony, when administered in small and repeated doses. This substance possesses, in a general sense, the power of lessening the irritability of the stomach (in relation to its own virtues), where the doses are small at first, and gradually increased. From this principle, indeed, results the necessity of increasing the doses as far as they may be borne without nausea, for the purpose of maintaining the same influence upon disease as is exerted by the first and smaller doses. In this way, in certain affections, as in croup and rheumatism, we may sometimes rapidly increase the doses from the sixteenth of a grain to two grains, although the first dose shall have actually produced vomiting, while the two grains are borne without nausea. It is also certain that this progressive increase of the remedy, as far as may be admitted by the stomach, is indispensable to the full influence upon disease which was exerted by the smaller doses before the remedy had subdued the irritability of the stomach.

Now were the physical, and not the physiological, doctrine true,

there should be no necessity for this regular and rapid increase of the doses. The nearer, indeed, each dose approaches the point of nausea, so will the general arterial excitement, and local inflammations, be held in subjection; from which it is plainly manifest that the remote effects depend upon the amount of influence produced upon the stomach. And so of opium, and all the narcotics, and, indeed, of various other agents which are freely assumed to operate through the circulation.

But again, on the contrary, we may obtain an exactly opposite series of results from tartarized antimony; by which we prove our proposition by the converse of the foregoing phenomena. We may begin the treatment by one eighth of a grain without producing nausea; but in an hour or two afterward, a repetition of the same dose nauseates the stomach, and prostrates the whole system. Again, at the same interval, we repeat the same dose, and vomiting ensues, accompanied by still greater constitutional effects. We then reduce the quantity to the twelfth of a grain, and again we have nausea and vomiting, with still greater constitutional results. We go on to reduce the dose in this manner, and, as I have witnessed in adults, it has been necessary to diminish the quantity to the thirtieth part of a grain to avoid protracted nausea, and a general prostration of the system. Here, then, the remedy not only continues to nauseate the stomach in greatly diminished doses, but, as in the opposite case, there is a constant ratio between its impression on the irritability of the stomach and its constitutional influences and its special effects on diseased remote organs. However the dose may be diminished, so long as it impresses the irritability of the stomach, it breaks down the general arterial excitement, and often overthrows inflammation just as fully, and rapidly, as when two grains are administered with a similar effect upon the stomach. Nor is this all which antimony opposes to the doctrine of absorption; since in the cases first supposed, when it finally produces nausea after repeated and gradually-increased doses, it does not reduce the irritability of the stomach after that dose, as after the beginning of the remedy, and when it did not produce nausea. On the contrary, the gastric irritability is now brought up to a full relation to the remedy in that last dose, where it either remains permanently for some time, or is quite as apt to increase in susceptibility to the antimonial influence, so that it may be necessary to diminish the next following dose to avoid a renewal of the nausea, and perhaps vomiting. In the mean time, the effects on the constitution, and on remote disease, are exactly conformable to the amount of influence upon the stomach.

904, *c.* Pereira has rendered our best standard work on Materia Medica liable to the objection which I am now considering, as he has, also, to that of reasoning from the effects of remedies on man in health, and even upon the naturally modified constitution of animals and plants, to the altered susceptibilities of man as they exist in disease. Of tartar emetic, he says, we do not know "the mode in which it produces its curative effect." And again,

"Shall we deny the efficacy of bloodletting in inflammation, of mercury in syphilis, of cinchona in intermittents, and of a host of other remedies, simply because we *cannot* account for their beneficial effects? The fact is," he continues, "that in the present state of our

knowledge, we cannot explain the *modus medendi* of a large number of our best and most certain remedial agents."—(PEREIRA's *Mat. Med.*, vol. i., p. 417. 1839.)

This supposed ignorance is mostly predicated of the failure of detecting the medicines in the circulation; but will it apply to such observers as explain their *modus operandi* on other principles, and in conformity with well-established facts? If "bloodletting be efficacious in inflammation, mercury in syphilis," &c., they are so through great and immutable laws; and shall we rest in ignorance of those laws because we cannot deny the efficacy of the remedies? Is it not this very common representation of the topics before us, and of the phenomena of living beings, which has led to so general a disregard of the great principles in medicine, and to the revival of the exploded creeds of the iatro-chemical and iatro-mechanical philosophers? Or is it any argument against the interpretation of the properties and laws of organic beings, of their modifications in disease, of the *modus operandi* of remedial agents, as set forth by one inquirer, that fifty different and conflicting systems have been projected by others? Such, indeed, must be the position of every disputed topic when universal truth shall ultimately prevail. The argument, therefore, however common, is necessarily fallacious.

There is no objection to admitting that all remedial and morbific agents find their way, very scantily, into the circulation, excepting as it regards the matter of fact, and a respect for those principles which nature has ordained for their exclusion so far as to prevent their ingress in injurious quantities. No conclusions, as I have shown, can be formed from the effects of injections into the circulation; which are the rudest facts in relation to a topic of this nature. It therefore becomes the merest assumption to affirm that the minute proportions of medicines, which may steal their way through the well-guarded portals of the organism, produce those remarkable results which we witness after their administration by the stomach; while we are met at the threshold of the inquiry by the clearest interpretation of their *modus operandi* in the perfectly demonstrable laws of sympathy, in a stupendous display of the operations of the nervous power in the natural conditions of the body, and as modified by a vast variety of experiments, and by the morbid processes that are perpetually before us.

904, *d*. Again, take the grand characteristics of the cinchonas, arsenic, calomel, and the whole group of agents for intermittent diseases. Of cinchona, Pereira says (after having expounded its operation as a tonic through the process of absorption), that in intermittent diseases its "*methodus medendi* is quite inexplicable."—(*Ibid.*, vol. ii., p, 1002, 1006. 1840.) But, is not its mode of operation just as intelligible in one case as in the other? Does not the whole system of nature, where common results are concerned in any integral part, enforce the belief that the same laws are concerned in both cases; and do not all the relative facts in physiology, all that is known of the properties of life, and of the constitutional effects of vital stimuli of any denomination, proclaim the fact, that nature is just as consistent in this instance, as she is in the simple principles which determine the phenomena of gravitation, of chemical affinity, of the attraction of cohesion, of repulsion, &c., or, in more sensible physics, of electricity, of light, of magnetism, &c.? If we refer, as does Pereira, to the effects

of cinchona as a tonic, upon the healthy system, we must explain the *methodus operandi* before we can apply it in the least to any parallel effects upon morbid and enfeebled states of the system. But we may not speak of "augmentation of cohesion of the organic mass," &c. (§ 890, 890½).—*Ibid.*, p. 1002. These are only effects of an antecedent operation, in which the whole *modus operandi* consists (§ 842). But the mode in which cinchona produces its effects in the perfect organism being just as obscure as in diseased states, we start with our interpretation of its *modus operandi* in intermittents, just as we do of the mode in which cinchona produces its fullest effects in health; or raises the vigor of the stomach, sharpens the appetite, and braces up the animal man, in dyspeptic affections.

Now the mode in which cinchona accomplishes these last results is no more obvious than its action as a febrifuge. One must certainly be as plain as the other, since the essential influences and changes are exerted upon the organic properties of living parts, which are governed by simple and immutable laws. To explain the operation of a given cause upon two principles where the results are of the same genus, and nearly of the same species, would be to disjoint nature completely, and to render her a deformity.

With this fundamental principle, we move forward to the interpretation of the effects of cinchona when it exasperates or produces disease; and so of other morbific agents. All the results, as they vary from those which follow the ordinary stimuli of life, depend upon the mutability of the organic properties and actions. Upon these, morbific causes, like the natural vital stimuli, make their whole impression; but they go farther in that impression than the natural stimuli of life. That is to say, they make their impression so profoundly, and in virtue of their peculiar attributes, as to alter the natural condition of the organic properties and actions; and this alteration constitutes disease. All that follows are but mere "sequelæ." Remedial agents, as we have seen, are capable of doing the same thing; and when direct in action, they operate upon the same principle. It is for this reason, therefore, that they produce disease in the healthy organism; and when they contribute to the cure of disease, it is in virtue of that morbific action which they exert on healthy parts. They are a class of morbific agents, however, which produce only such diseases, in health (if not administered in great excess), as are of a transient nature; and when, therefore, administered for the cure of disease, they induce a morbid state more favorable than the pre-existing to the natural tendency of morbid organic properties and actions to return to their healthy standard.

Thus we get at a common principle of the *methodus operandi* of cinchona as a *tonic*, as a *febrifuge*, and as a morbific agent; and it is equally applicable to all other remedies which possess absolute remedial virtues. This philosophy enables us at once to understand how arsenic, cobweb, opium, alcohol, moral emotions, and almost every thing else, are, like cinchona, more or less curative of intermittent fevers; and though the alterations which are directly instituted by these various agents are unlike in all the instances, and correspond with the peculiar virtues of each agent, each one induces such changes in the organic properties as enable them to take on their natural tendency toward a state of health,—some being more conducive than

others, and either liable to exasperate the disease. We thus see, also, how it is that our remedies must be well adapted to the existing pathology, or they will prove morbific; since their operation is as well regulated by the nature of the morbid conditions as by the virtues of the remedies (§ 79, 150, &c., 857, 890½ *d*, 892 *d*). We must look for the reason of this ready subversion of intermittent fever to solidism and vitalism. We must regard nature in her recuperative efforts, as strongly pronounced during the periods of intermission, and thus learn from her that the morbid properties of life may require but a slight impression to establish an unintermitting tendency toward a state of health (§ 177–182, 557 *a*, 756 *a*, 775).

That there *is* a *methodus operandi*, in all the foregoing cases, is too certain to be questioned; and such being the fact, it is quite a becoming occupation for the human mind to interrogate its nature; or as Bacon has it, "it is the glory of God to conceal a thing, and the glory of man to find it out" (§ 892, *b*).

905, *a*. I will now present a comprehensive example which illustrates the foregoing doctrines. A seton, passed through the skin of the neck, removes inflammation of the eyes. In this instance, nothing can possibly enter the circulation, but the whole influence of the seton upon the eyes must be exerted through the medium of the brain and spinal cord. By tracing out all the effects of which this seton is capable, we may show that it involves all the principles which are concerned in the production of disease and its cure (§ 63–81).

In the first place, the seton establishes an inflammation in the part of the skin in which it is inserted. Here we have the whole interpretation of morbific agents in producing their primary diseases. Like the seton, all others act upon the irritability of parts, to which they are applied, alter its nature, and involve the other organic properties in corresponding changes, when a change of function ensues as a consequence; and then may follow a variety of physical results.

Now let us consider the seton in its curative aspect, as it relates to the ophthalmic inflammation. The morbid state of the skin operates as a peculiar stimulus, the result of which is transmitted to the cerebro-spinal axis, where it develops and modifies the nervous power, which is then reflected upon various parts. But the intensity of the nervous power, thus developed, is not sufficient to alter the organic properties of any part excepting the susceptible ones which conduct the inflammatory affection of the eyes through their instruments of action, and therefore no sympathetic disease is produced. But irritability being preternaturally susceptible in the inflamed eyes, the nervous power operates with effect upon it, and alters the nature of that and other properties so as to enable them to return to their natural state; and thus the inflammation subsides (§ 150, 151).

We will next see how this seton may become the cause of sympathetic diseases in remote parts, and we shall then, also, have the whole of the principle which is ever concerned in the development of secondary diseases; and we shall see, too, that the principle is precisely the same as that which concerns the curative effects of remedies when they operate upon remote parts through the medium of another part; as in the curative effect of the seton upon the inflamed eyes.

Let us, then, suppose that the seton is permitted to remain in the neck after it has accomplished the cure of the eyes, till, finally, it ex-

cites a severe degree of inflammation in the surrounding skin. By-and-by, we find the patient beginning to lose his appetite, the tongue coats up, and other marks of a diseased state of the stomach set in. This organ, therefore, has become involved in disease in consequence of the neglected and irritative state of the seton. Still, however, the mischief is allowed to go on, and the eyes, which had been relieved by the seton, again become inflamed. The seton has been the essential cause of this round of phenomena; and since nothing can have been introduced into the circulation, from beginning to end, we must look to the nervous influence for the remote developments of disease, as in the former case for the curative results (§ 514, *h*). The seton, after the cure of the eyes, had taken on a higher and modified state of inflammatory action, and it transmitted to the brain and spinal cord such influences as developed the nervous power in greater intensity and a more morbific condition. This state of the nervous power, being reflected abroad, fell with greater force upon the stomach than on other parts, from its peculiar susceptibilities, and its close natural relations with the skin and cerebral system (§ 233¾). The stomach has also the eyes much under its control, and the eyes are now particularly liable to be injuriously affected by sympathies propagated from the stomach on account of their recent inflammation, which left them in a more than usually susceptible state. The stomach, therefore, in transmitting its morbid impressions to the cerebro-spinal axis, co-operates with those from the seton in increasing the nervous influence; which, being determined with a morbific effect upon the eyes, produces the ophthalmic inflammation.

We have now to consider the natural tendency of the properties and actions of life to return from diseased to their healthy states. The seton, as we have seen, is the sole cause of the new developments of disease in the stomach and eyes, and these effects are maintained by keeping up the irritative inflammation of the skin. If, therefore, we withdraw the mechanical irritant from the skin, the inflammation of the part will subside spontaneously; and having thus removed the exciting cause of disease in the stomach and eyes, these parts, also, return spontaneously to their healthy states. Thus it is, also, that the irritation of setons, issues, blisters, &c., when applied over the joints, &c., for the removal of inflammatton of the ligaments or other tissues, may, after having greatly fulfilled their purpose, ultimately keep up a degree of the disease, or increase its intensity. But, if the skin be now healed, the disease will subside spontaneously,—the very healing of the skin reflecting salutary influences. This is often verified by the effects of remedies when administered internally; disease being ultimately aggravated by the means which were at first curative, but again yielding with rapidity as soon as the remedy is discontinued. In all the cases, the ultimate subsidence of the aggravated conditions of disease is owing to the artificial modifications of their pathological cause. This recuperative law lies at the foundation of therapeutics, and it shows us that the first and greatest step in the treatment of diseases is to remove their exciting causes; when nature may require no other assistance from art.

The only remaining consideration to complete the essential philosophy of the operation of remedial and morbific agents, relates to the direct action of remedies in curing diseases of parts to which they

may be applied. If an emollient poultice, as it is called, or opium, or leeches, &c., be applied to the inflamed skin, they may hasten the subsidence of the inflammation. This is done by their direct alterative action upon the diseased properties of the part, as in the case of morbific agents; and in proportion to the subsidence of the primary affection may be that of the sympathetic diseases. But, the sympathetic affections may be also hastened in their decline by the direct application of remedies to the sympathizing parts; or, we may contribute to the cure of the whole by addressing remedies directly to one of the organs which has been sympathetically involved, as to the stomach in the foregoing case; or, the sympathetic affections may go on independently of the cure of the primary disease, and require a distinct treatment; or, it may be necessary to cure them first, before the primary disease can be removed. The diseased state of the stomach, for example, in the foregoing case, may, in its turn, establish a morbid sympathetic influence over the seton, and thus complicate the principle as to exciting causes, and institute a mixed condition of sympathetic influences. This, in fact, is more or less the case, in most diseases, after the morbid state is propagated from the primary seat. In the example now stated, all the diseased parts act and react upon each other, each becoming a point of departure for the development of a morbific nervous influence, and each affection, therefore, contributing to maintain and aggravate the others. Other organs join in, though perhaps not essentially disturbed, and take their part in the disease, according to their degrees of affection, and more or less, also, according to their relative vital importance and constitutional relations; while the great movement of diseased action may be variously influenced by the contingencies which grow out of constitution, temperament, age, habits, external influences, &c. (§ 512, &c.).

And so, on the other hand, when the curative process begins, whether instituted by nature or by art, the whole organic system may concur in the salutary change which is started at a single point (§ 143, *c, and references there*).

905, *b*. The vast advantages which are every where arising from warm poultices, and warm fomentations, both in the hands of the physician and the surgeon, lead me to advert still farther to the philosophy which concerns their effects, in the hope that it may lead not only to their more frequent substitution for powerful agents, or for the surgeon's knife, and, therefore, to a better appreciation of the recuperative law, and a greater reliance upon Nature herself, but that it may contribute light upon the fundamental cause of disease, and the remedial action of all things else.

In what I have hitherto said of the foundation of disease in common physiological principles, and of the near approximation, in their pathological states, of all the varieties and modifications of inflammation, in connection with what has been variously and specifically stated of the common mode of action which obtains with all efficient remedies, from the vesicant to the sedative, it is evident that the remedial action of poultices, and hot fomentations, falls under the universal philosophy. From blisters and irritating cathartics we readily pass along an intermediate series of analogies that are represented by other agents till we arrive at tonics and stimulants. In a former section I was employed in endeavoring to show, through the operation of these last

agents, that there is no ground whatever for the distinction which has been made of inflammation into active and passive, or sthenic and asthenic, conditions (§ 733 *f*, 752–756). The example supplied by erysipelas, in which blisters and leeches may afford relief, when applied to the inflamed surface, either separately or conjointly, is only another impressive evidence of the close approximation of the various pathological states of inflammation; and the variety in the remedial virtues of the curative agents which have now passed under review go to prove that they operate merely by inducing conditions of disease more favorable to the recuperative process. Loss of blood produces one kind of change, cathartics another, tonics another, vesicants another, and so on; but each one induces a change from which the morbid properties are capable of passing to their natural state (§ 892¾, *b*). These principles enable us to understand how a great variety of physical and moral causes will often succeed in removing some particular malady, as one or another may be brought into action at its different pathological phases, as in intermittent fever; and reconcile, also, those embarrassing contrasts which have led to many errors in pathology and therapeutics, as when tonics and stimulants remove inflammation, or when patients equally survive the treatment of gastro-enteritis by capsicum or lobelia, as practiced by the bold and unprincipled empiric. A more violent inflammation may be the temporary consequence; but it differs from the original in being modified by the peculiar morbific virtues of capsicum or lobelia, and in which modifications the diseased properties are sometimes capable of exerting their recuperative energy.

This conducts me to a more circumstantial exposition of the remedial action of local sedatives, especially of those for which this section was designed. In the mean time, however, on looking at the group of *local sedatives*, as arranged in my Materia Medica, we find linseed, and bread and milk poultices, holding the very first rank, while sedatives of the most active virtues, such as stramonium, aconite, belladonna, cicuta, cyanide of potassium, morphia, opium, henbane, &c., follow the poultices and hot fomentations as inferior remedies.

But this arrangement, like that of all other groups, is founded upon the supposed relative usefulness of the several agents in fulfilling the objects of each group, respectively. Since, therefore, emollient poultices and warm fomentations effect the greatest amount of relief, and are far more generally applicable in practice than all the rest, as local sedatives, they should hold the first rank in the arrangement, notwithstanding the activity of their virtues is immensely less than that of the other substances which I have mentioned. It is the effect of all, however, to lessen irritability and sensibility, and thereby to moderate or subdue inflammatory action. But many of the local sedatives go farther than this. They also affect irritability and sensibility, especially the former property, in their existing nature or *kind*, and, of course, induce a corresponding change in the *kind* of action. Now, it is this alteration in *kind*, beyond the mere sedative effect, which makes up the differences between the various agents of the group of local sedatives. Poultices and warm fomentations produce the least of this change in kind; their effect scarcely reaching beyond that of reducing an exalted state of irritability and sensibility, or of keeping it down

where it is liable to ensue. The acetate of lead follows next, in this simple but most valuable effect.

The foregoing moderate influences, with little or no specific alteration in *kind* of the morbid properties and actions, is just what is wanted in a vast number and variety of morbid states, as in superficial inflammations, abdominal irritations, sprains, bruises, piles, &c., or as means of prevention in the hands of conservative surgery. There is nothing comparable, for these purposes, with warm poultices and warm fomentations. Their immense services in the healing art, I say again, should turn the attention of physicians and surgeons with increasing reliance upon recuperative Nature. Let us study the precepts as inculcated by the fathers of medicine, an imbodiment of which may be seen in three of the *mottoes* at the head of a former section (§ 894).

In respect to the poultices, &c., no doubt the moist heat exerts some slight alterative effect beyond that of simply reducing the exalted properties and actions of inflammatory conditions. But, all the other changes and results which take place are brought about by Nature, and not by the poultices (§ 878).

If local inflammations, to which poultices and warm fomentations are applicable, have given rise to constitutional disturbance, or to inflammation of other parts, these sympathetic results may subside spontaneously when the primary disease gives way. But the poultices have nothing farther to do with any of these great movements of Nature, than simply to lessen the irritability of the inflamed part with which they are in contact. In conservative surgery, poultices have even less participation in all those terrible compound fractures and dislocations whose cure they enable Nature to conduct with but even little inconvenience to their subjects, and which, till in recent times, were doomed to the amputating knife. In all these cases, the simple agents are only instrumental in keeping down irritability, and thus preventing inflammation and constitutional disturbances. They act merely upon the principle of keeping exciting causes out of the way of Nature (§ 856, *a*).

Finally, a word as to the contribution which is made by these great remedies toward the resolution of those phlegmonous inflammations which are disposed to result in suppuration, or how, in other cases, they promote that disposition.

If the phlegmon have not reached the turning point, as it were, of the inflammatory process, or when the formative is about passing into the suppurative stage, an emollient poultice, by lessening irritability, will be very likely to promote resolution, and thus to prevent the suppurative stage.

But, when suppuration has begun, Nature, herself, has taken on the work of cure, and an abatement of morbid irritability is the first recuperative change in this natural process. Now it is, therefore, that poultices, through their tendency to lessen morbid irritability, co-operate with the natural process, and thus promote suppuration (§ 733, 735 *a*, 862).

GENITO-URINARY AGENTS.

905½, *a*. In consideration of what I have said of *Emmenagogues* (§ 892⅔, *q*), and to illustrate yet farther the action of remedial agents, before entering upon the subject of bloodletting, I have concluded to

set forth the ground of distinction which induced me to assemble into two groups those agents which bear the general denominations, in my Materia Medica, of *Uterine Agents*, and *Genito-Urinary Agents*. By introducing, also, the several members of each group, along with the numerical order of arrangement, it will be farther seen how far the arrangement has been founded upon physiological principles, and how far it is adapted to the modifications which are presented by pathological conditions (§ 137 *d*, 872 *b*, 892⅘ *b*, *c*). There will be thus, also, farther exemplified the relative specific relations of many remedial agents to certain tissues, or parts of a common tissue, and farther, also, by the recurrence of the same agents in different groups, their therapeutical capabilities in their aspect of compound virtues (§ 129, 135, 136, 137 *b*, *c*, 150, 151).

Uterine Agents, *in the order of their value* (*numerically*).—1. *Secale cornutum.* 2. *Oleum ergotæ.* 3. Cantharis vesicatoria. 4. Sanguisuga. 5. Guaiacum officinale. 6. Juniperus sabina. 7. Ferrum, et ferri sales. 8. Aloe socotrina. 9. Balsamodendron myrrha. 10. Hydrargyri sub-murias, etc. 11. Hydrargyri iodidum. 12. Iodinium. 13. Potassii bromidum. 14. Ferri bromidum. 15. Ipomæa purga. 16. Juniperus Virginiana. 17. Aristolochia serpentaria. 18. Ruta graveolens. 19. Ferula asafœtida. 20. Sodæ biboras. 21. Mentha pulegium. 22. Helleborus niger.

Genito-Urinary Agents, *in the order of their value* (*numerically*).—1. Copaifera multijuga. 2. Piper cubeba. 3. Cantharis vesicatoria. 4. Strychnos nux vomica. 5. Barosma crenata. 6. Abies balsamea. 7. Oleum terebinthinæ (pinus et abies). 8. Pistacia terebinthus. 9. Arctostaphylos uva-ursi. 10. Cissampelos pareira. 11. Laurus camphora. 12. Tinctura ferri sesquichloridi. 13. Chenopodium olidum. 14. Chimaphilla umbellata. 15. Cinchona officinalis. 16. Amyris Gileadensis. 17. Pistacia lentiscus. 18. Physalis alkakengi.

905½, *b*. The foregoing assemblages suggest, by the remedial virtues of the several members of each class, respectively, a great variety of pathological conditions relative to the uterus in one case, and, in the same manner, the genito-urinary organs in the other. We have already seen how ergot is mainly useful in parturition; and, in no. 20 of the same class, an inferior substance occurs which has been supposed to promote the effect of ergot as a parturiant agent. The other members of the Class of Uterine Agents are such as are denominated emmenagogues, with the exception of the fourth. But, leeches should evidently follow cantharides, in the order of importance, as capable of yielding relief, not only in the next greater number of cases, but in very difficult pathological conditions of the uterus; while the high place which they occupy is significant of irritable and inflammatory, or congestive affections of the uterus which may often call upon their aid, and admonishes the practitioner to beware of most of the other agents which follow. It is not, however, to such cases alone that leeches to the perinæum are appropriate, but to many cases where menstruation has been long arrested by slight derangements of the uterus, as sympathetic consequences of gastric or other abdominal derangement, but where the influence of vital habit is such that neither cantharides nor the stimulating emmenagogues, if admissible, will affect the condition of the organ; though its susceptibility to these agents may be established by leeching (§ 137 *d*, 892¾ *q*, 893 *q*). Should leeching, there

fore, fail, it is appropriate that an emmenagogue which may now succeed, and often by itself, should stand next in the order of arrangement; and of these, guaiacum is the best.

It need scarcely be said, that in the reference which I have made to emmenagogues in section 892⅔, *q*, that I mean alone those which have been hitherto grouped together with a special reference to *the symptom*, and upon which the denomination has been founded (Εν, in, μην, month, and αγω, to lead).

We soon come upon the ferruginous preparations, and these, again, are significant that the uterine embarrassment often grows out of indigestion, or, less frequently, that some primary affection of the uterus has been the sympathetic cause of a gastric derangement that reacts upon the uterus and maintains its pathological condition (§ 902 *b*, 905 *a*). But, it does not often happen in primary uterine affections that an appropriate treatment will not readily succeed; especially leeches, if inflammatory, or, otherwise, cantharides, and the subordinate means. Such, however, is the disposition of the system, especially of the digestive organs, to sympathize with inflammatory, or irritable states of the uterus, that these cases soon become complicated, and we may then turn to the example of the seton for the principles of treatment, nor waste our efforts at unavailing attempts with emmenagogues addressed to *the symptom*, or to a more rational view of the pathological state of the uterus alone.

Where ferruginous agents are proper, so, also, in a general sense, is guaiacum, or some analogous means. But, the attendant gastric derangement is apt to be accompanied by constipation, which is more or less dependent on an associated functional derangement of the liver (§ 129). Aloes, therefore, properly follows next in the order; and, although this is down in the books as an emmenagogue from its supposed propagation of special influences from the rectum to the uterus, I apprehend it is in no other way a uterine agent than by contributing relief to hepatic disorder, augmenting the natural stimulus of the intestine, and, in other ways, removing constipation, and thus, also, *the symptom* (§ 889 *i*, 889 *l*, 902 *b*).

The simple mercurial preparations, which follow as the tenth in order, equally admonish us, also, to keep our attention upon the pathological condition, and away from *the symptom*, excepting as it is very vaguely significant of some morbid state of the uterus which can only be known through other phenomena. The rank of this agent implies, also, its degree of utility, the ratio of its frequency in contributing aid, its adaptation to a variety of pathological conditions that may be complicated with the uterine derangement, and the probability that it may be advantageously associated with leeching, and only as a subordinate agent. It comes into use, especially, in inflammatory states of the uterus, or when hepatic derangement takes the lead, and is inobedient to milder treatment.

The next are the iodides of mercury, and the bromides of mercury are about the same; and, who does not see that their special reference is not to the uterus, but to some other visceral derangement; perhaps of a syphilitic, or scrofulous nature, or under those diatheses? But which, and how much, what the pathological shades, what the exact condition of the uterus, how far it receives and reflects sympathetic influences, are matters for critical inquiry (§ 894 *b*, 901, 902 *b*).

The union of mercury with iodine also suggests a general antiphlogistic treatment, and that, like the more simple mercurials, it may be often associated with leeching.

Iodine or the bromide of potassium is wanted next, on account of the scrofulous diathesis; and this is about the amount of its bearing upon *the symptom*. It denotes that the uterine function is often suspended by chronic visceral disease which has gone on to disorganization, especially of the liver or spleen; though, in other cases, it supposes the same condition of the uterus as a primary affection (§ 892½). It may be only the indigestion so often incident to the scrofulous constitution, which arrests menstruation, and often without much derangement of the uterine system; and here iodine contributes an important aid. The uterus surrenders as soon as the morbific sympathetic influences are withdrawn. The bromide of iron may be often now called in advantageously (§ 150, 151, 894 *b*, 901, 902 *b*).

Jalap is wanted to carry out a decisive antiphlogistic treatment, which is occasionally demanded; sometimes for primary inflammation of the uterus, or again for some general plethoric habit, or some obstinate chronic gastritis, and where the functional derangement of the uterus is of very little importance. In many of these cases, general bloodletting should take the lead in the treatment; and the menses may start under the beginning impression of the remedy (§ 872 *b*, 892¾ *b*, *i*).

But, there are no cases which so constantly baffle the practitioner as those which are presented by the nervous temperament; and these are common (§ 601). A reference to the characteristics of that temperament will show us, at once, how it has happened that asafœtida is the only agent that has been introduced with a specific reference to *the symptom* in this class of remedies. The whole body is so alive to sympathetic influences, as disease may touch upon one part or another, and more profoundly as it may plant itself in greater force, that nothing can be now accomplished but through the precepts of the most enlightened medical philosophy. It is here, too, that we see most distinctly pronounced the complete possession which gastric derangements may take of the uterus, and overthrow its function, or where it may be interrupted by a sudden reduction of the temperature of the feet, or by a midnight frolic, or by drawing the habitual corset a little tighter. Now, too, any disturbance of the uterus, whether primary or secondary, reacts on most other parts, while they, in their turn, resent, as it were, the injury (§ 514, *h*, &c.). The treatment of these cases, therefore, may be as complex as the morbid sympathies. But, in a general sense, the best, and often the only requisite, emmenagogue will consist of a carefully-regulated diet, early sleep, free exposure to the open air, accompanied with a suitable kind of exercise, sometimes shower bathing, or, at other times, warm bathing, removal of corporeal restraints, cheerfulness of mind, and a little rhubarb and magnesia, to improve digestion, keep down acidity, and to help any sluggish state of the bowels. We must repair the constitution of these patients; and there will then be no difficulty with *the symptom*. It has been a neglect of the means, the neglect of pathology, and the *name* of emmenagogue, which have led to most of the failures of art, and have contributed to swell the nomenclature of "nervous diseases" (§ 659, 855, 856, 878, 902 *m*). Nor has the fashion of "*Specialities*,"

which forms one of the perversions of morbid anatomy, as handed over from France, and one of the roads to distinction and practice, been wanting in a liberal contribution to the very errors which it professes to reform. The principal observers are generally able, always industrious; and would they but merge their tangible, isolated objects in the comprehensive philosophy of medicine, they would give an impulse to science, and a direction to practice, which would bring honor to themselves, and bestow a service on mankind. We need no better demonstration of this than what I have just been saying of the nervous temperament (§ 701, 960 *c*).

905½, *c*. We come, next, to the *Genito-Urinary Agents*, where a great variety of remedial virtues occurs, but, unlike the case of emmenagogues, where all have a special reference to the genito-urinary system, with the uterus excepted but in its relations to cantharides and chenopodium. It is a group, therefore, which illustrates, throughout, what is denominated specific action, and exemplifies extensively the special modifications of irritability in different parts of the body (§ 133, &c., 150, 191).

When, therefore, these agents are employed with reference to the genito-urinary system, their local action is alone contemplated. The favorable changes which they induce are of a direct nature as it respects that system of organs; and they do not, therefore, contribute relief by effecting the removal of diseases situated remotely from those parts (§ 905½, *b*).

Hence, it is readily seen how liable to misapplication such a group of agents must necessarily be without a sound knowledge of physiology, and an enlightened view not only of the general conditions of disease, but of the pathological varieties and shades of difference which are constantly presented by any given common form of disease; especially of inflammation (§ 639 *a*, *b*, 650, 662, 669, 671–674, 718, 722, 819 *a*, *motto*, no. 7). To such an observer the assemblages in the various groups are peculiarly valuable, and for such, indeed, are they alone designed. To him, each group, each remedy, every virtue in a compound remedy, and whether so by Nature or by art, has its individuality, which is recognized as the eye glances from one agent to another, while it carries along an associated recognition of a vast variety of pathological states, and a just appreciation of the relative therapeutical value of the various means which may be the subjects of his transient inquiry. But, the group now under consideration, being exclusive, and, withal, not as liable to morbific effects as are most other classes, the uninformed has less chance at mischief than when he approaches the cathartics, &c.; where physiological and pathological knowledge is far more important.

It is readily seen, therefore, that one, or more, of the foregoing agents may be exactly adapted to a given modification of disease, inflammation, for example, affecting either the mucous tissue of the vagina, or of the bladder, or of the urethra, while it would be very unsuited to another modification; and, from what we have seen of the natural modifications of the vital constitution in the same tissue as it may occur in different compound organs, and in different parts of a continuous tissue as it traverses different organs (§ 134–137), it is evident that great circumspection is often necessary in the application of these agents; and farther, also, that what may be immediately useful

in some special state of inflammation as affecting one of the several parts of the genito-urinary mucous tissue, may be detrimental in an apparently coincident form of the same disease in either of the other parts; and vice versa (§ 137 *c*, 150, 151, 870 *aa*). Here we have, for example, amenorrhœa, as considered in the foregoing section, depending on active inflammation of the uterus, where general blood-letting may be demanded, and may be sufficient; but, in event of its failure to establish menstruation, cantharides, which would have been otherwise pernicious, may now complete the requisite instrumentality of art (§ 137 *d*, *e*, 143 *c*, 859 *b*, 863 *d*, 867, 871, 905½ *b*.)

Take, next, the same agent as the best internal remedy for leucorrhœa. Here, again, the inflammatory states, which constitute that affection, vary constantly, not only as to force and habit (§ 535, &c.), but more greatly in the absolute modifications of inflammatory action. For all this knowledge, we must go to our general principles, then to all the minutiæ of symptoms (§ 685, 686). Among the last, none are so important as the exact character of the discharge, which varies, by gradations, from purulent to mucous, and from this last to a bloody, or a brown watery, or a more simple watery fluid; just as we have seen of analogous phases in the condition of ulcers, or of intestinal inflammation (§ 693, 740). Now, it is clearly wrong to treat any one of these several conditions exactly in the same manner; and where the differences are broadest, so, also, must be the variations of treatment. In indolent states of the disease, and where the discharge is mostly purulent, if the general health be tolerably sound, we may proceed, at once, to the exhibition of cantharides; and, as soon as slight strangury takes place, the disease will generally surrender. But, should it, in the cases supposed, refuse to submit, or should the individual be insusceptible of the special action of cantharides, as will commonly be denoted by the failure of its effect upon the bladder, we may safely and commonly with certainty of success, resort to vaginal injections of the best nitrate of silver, in proportions varying from three to four grains in an ounce of water. But, if the discharge consist of mucus, or any other than the puriform matter, cantharides will aggravate the affection, and the nitrate of silver, at most, will do no good. If it be mucus, it denotes an intensity of inflammation, which calls, at least, for a simple vegetable diet, and, probably, for leeches to the perinæum, along with the general antiphlogistic treatment. In these cases, therefore, we have nothing to do with the genito-urinary agents. Equally inapplicable, also, are they to those pathological states from which result the watery discharges; and here we are completely thrown upon the special circumstances of every individual case, and upon the general principles of the science.

This last remark leads me to another more important than the rest; namely, that all the pathological varieties which go to constitute *the symptom*, may be variously complicated with morbid affections of other important organs, especially those of the abdomen; just as we have seen of the *symptom* in amenorrhœa (§ 905½, *b*). This, indeed, is always the case in the watery discharges, almost always in the mucous, and very often in the puriform. In all the cases, too, the vaginal or uterine affection may be entirely a sympathetic result of primary disease in the digestive organs; and such is usually the case where the discharge is of a watery nature. We may be sure, however, that

the sympathetic affection will react upon the system at large, especially in the more intense form which is denoted by the mucous product; and this, whether the genital affection be primary or secondary.

Here, then, we must apply ourselves to the general health, attack what may be the citadel of disease; but, to do this efficiently, and that our prescriptions may carry with them the combined virtues of *tuto, cito, et jucunde,* the practitioner may not undervalue the Institutes of Medicine.

Whenever the uterus is the seat of disease in its mucous tissue, like all other organs which may be especially affected in one of its parts, the other component parts suffer, more or less, sympathetically (§ 138, 141 *b*, 514 *f*, 528).

A common form of discharge takes place from the uterus, which is more or less of the nature of lymph. Here there is pretty high inflammation, as well as obstinate. It calls, of course, for general bloodletting, leeching, &c.

Copaiva is the first among the agents in the group before us. This denotes the frequency with which it is called into use in the treatment of gonorrhœa, and its relative value for this specific purpose. Cubebs follows next; and as two agents of similar virtues in relation to a specific object, and of nearly equal pretensions, and both of them stimulant, lead off in a general class of remedies, they are, by the position they occupy, standing mementoes of the frailty and vulnerability of man, and incentives to study well the varying conditions of gonorrhœa. Here we have rarely more than a local complaint for our professional skill; and yet, how much suffering is inflicted, how many made wretched in their domestic relations, by the indiscreet use of these two valuable agents, and by astringent injections! The haste of the patient may be always moderated, or conquered, by firmness in the appropriate means, and the practitioner rewarded in conscience, and thanks, where he may elect, for the preliminary treatment, that antiphlogistic plan which will speedily prepare the way for the remedies of more local action, if it do not in itself succeed. Here, too, we may notice in the contingent circumstance, as in all other groups, that when gonorrhœa yields to general or local bloodletting, or to cathartics, or to water gruel and perfect rest alone, another of the multifarious demonstrations of the common mode of *Remedial Action.*

THE INFLUENCES AND MODUS OPERANDI OF LOSS OF BLOOD,

Considered with a Reference to the practical Application of the Remedy and the various Circumstances of Disease.

906, *a.* "The serous portion of the blood, or even pure blood, may escape from the over-distended vessels, *just as water transudes through the permeable sides of a vessel, in which it suffers compression.* To this source are to be referred several hemorrhages and dropsies produced by simple transudation in a tissue *mechanically congested;* and although these affections have really *nothing active* in their nature, yet are they considerably diminished, and sometimes altogether removed, by bloodletting, which, in such cases, acts in a manner *purely mechanical,* by removing from the vessels the fluid by which their parietes were kept in a state of over-distention."—ANDRAL's *Pathological Anatomy.*

b. "If bloodletting be considered in a *mechanical* light, as simply lessening the quantity of blood, I cannot account for its effects; because the removal of any natural mechanical power can never remove a cause which neither took its rise from, nor is supported by it." —HUNTER *on the Blood and Inflammation.*

c. "It is a *great modern improvement* in the practice of the healing art, in bleeding for the cure of inflammation, to take the blood away as *quickly as possible;* since intense inflammations of the brain, lungs, bowels, &c., *are equally removed* by faintness, whether it happens after the loss of ten ounces of blood, or of fifty; or even, as sometimes occurs, when it happens without bleeding at all, after merely tying the arm in preparation."—ARNOTT's *Elements of Physics.*

d. "If we have to deal with an extensive and violent inflammation, we do not abstract blood by a minute opening; we make a large orifice, or we open a vein in both arms at the same time; we place the patient in an erect posture, and endeavor to produce deliquum. It sometimes happens that the patient *faints from fear,* or before any considerable quantity has been lost; and *this faintness,* as Dr. Arnott remarks, *answers as well* as that which results from venesection" (§ 960, *a*).—GRAVES, *in London Med. and Surg. Journal,* vol. iii., p. 391.

e. Ad extremos morbos extrema remedia exquisite optima."—HIPPOCRATES.

906, *f.* WHETHER the father of medicine, or his modern descendants, be right or wrong in the foregoing precepts, especially in relation to the therapeutical uses of bloodletting, it will be an object of the present inquiry to ascertain (§ 376¾, *a*). The contrast of views, especially when we consider the details inculcated by Hippocrates in respect to loss of blood, as well as other remedies, suiting them all to the exigencies of disease, or leaving the whole work to Nature, and, with all his enlightened precaution, regarding the loss of blood as the *remedium principale,* renders it, I say, an object of deep interest to determine the nature of the right, and, in so doing, to ascertain, also, how far philosophy and practical habits have outstripped the Ancestor.

We may also, perhaps, come to some determination whether a knowledge of the principles upon which bloodletting operates be worthless, or necessary to its just and intelligible use (§ 893, *n*). Whether we should know what absolute influences it exerts, or how it exerts them, before we can appreciate its applicability, and its appropriate extent, in many important morbid states where the remedy may be more demanded than in other conditions whose phenomena clearly indicate its necessity (§ 857).

Perhaps, also, it may be useful to science, as well as humanity, to strip this remedy of its mechanical interpretations, and to place it upon that dignified ground surrounded by those hallowed laws of the God of Nature, which, if unacceptable to the materialist, will, at least, rebuke his sacrilege.

906, *g.* Before entering upon the investigation of this subject, I take leave to say, that the modus operandi of loss of blood, as set forth

in this work, is exclusively original with myself. If there be any merit in the philosophy, its abuse and misrepresentation by the *British and Foreign Medical Review*, and the *Medico-Chirurgical Review*, of London, entitle me fully to all the proprietorship. Whatever is said of the vital influences of the loss, and of the whole theory of the associate influence of the nervous power, appeared for the first time in the Medical and Physiological Commentaries (§ 222, *b*). Copyists, it is true, have appeared, especially of the accumulated facts, without the slightest reference to him who performed the labor (§ 435, *b*).

Although, therefore, the same philosophy, and the same practical applications of loss of blood, are preserved in the Institutes as set forth in the Commentaries, they are now rewritten and presented in another shape, with greater brevity, and with reference to that systematic order which shall best subserve the young Inquirer. The same is also true of other subjects which may have been investigated in the Commentaries.

907. Notwithstanding the practical importance of a distinct apprehension of the modus operandi of loss of blood, it should never be the leading indication for its use; but only subservient to the suggestions of the morbid phenomena, of pathological principles, and of experience. The just application of the remedy should be determined by these combined considerations.

908. Again, by taking a comprehensive view of the direct influences of loss of blood, we shall not fail to discover the close analogy of its modus operandi with that of all other remedies, and that it reflects an important light upon the whole ground of remedial action; while its loss involves in its effects some principles peculiar to itself.

909. The hypotheses which have hitherto prevailed respecting the operation of loss of blood have been, for the most part, mechanical; but I have demonstrated in my Essay on the Philosophy of its Operation, that the effects of bloodletting are wholly incapable of explanation upon any principles in physics. Like the action of all other remedies, there is nothing mechanical appertaining to any part of the process, excepting the escape of the blood from the orifice.

910. The numerous advocates of the mechanical doctrine of inflammation and venous congestion predicate their views of the operation of bloodletting in conformity with the supposed existence of passive relaxation of the affected vessels, and stagnation of blood within them, and extend the hypothesis to the hot stage of idiopathic fever. The philosophy, therefore, is vitiated by the pathological views upon which it is founded. Moreover, were the doctrine of debility (§ 569), passive relaxation of the vessels, and stagnation of blood, correct, it is evident that not only such conditions, but that the stagnated and coagulated blood, would not be suddenly removed by diminishing, to any extent, the general circulating mass, as is constantly witnessed in inflamed parts; while, also, were such a physical impossibility within the power of the remedy, those vessels would immediately become again congested, and the more so from the prostrating nature of the remedy (§ 935, 977).

911. General bloodletting, cupping, and leeching, manifest some important differences in their effects, but operate upon modifications of a common principle. A knowledge of these modifications is necessary to a right administration of the remedy, as it respects one or

the other modes of abstracting blood. Neither method has been founded upon any rational principle.

912. How, then, does bloodletting operate? How are diseased parts immediately and permanently unloaded of their blood, in some instances, by the abstraction of two or four ounces of blood, when, in other cases, under apparently the same circumstances, a great extent only, of the remedy will effect the same result? Why, in such cases, may the former quantity induce syncope, when the latter has no such effect? "Syncope," says Robert Jackson, "occurs sometimes in yellow fever from the loss of a few ounces of blood, sometimes scarcely from the loss of six pounds." Why does this coincidence obtain with so many other remedial agents? Why do we see the redness of an inflamed eye give way permanently while the blood is flowing from the arm, and why does the same change take place as rapidly, and even more perfectly, in any of the great organs when equally inflamed and loaded with blood? Why may the action of the heart be weakened by small quantities of blood taken by leeches, when larger quantities would be required to produce a similar effect by venesection (§ 889, *l*)?

Now it is obvious that the foregoing results can be explained only upon the physiological principles which I am about to set forth; while there is not one phenomenon attending all the diversified effects of loss of blood that is not susceptible of a clear interpretation upon those principles—an interpretation, too, which corresponds with all that I shall say of the modus operandi of every other remedial and morbific agent—nay, even with the natural stimuli of life.

913. The inquiry now proposed will extend from the beginning of the physiological influences, through their gradations, to their consummation in syncope. It will be also accompanied by practical illustrations, and by exemplifications of the various conditions of disease to which the remedy may be appropriate.

1. LEECHING.

914. It will be most useful, in the first instance, to observe the phenomena, and deduce the principles, which attend the direct abstraction of blood from those extreme capillary vessels which are the instruments of all morbid processes. Leeching, therefore, is first in order; the physiological effects of which may be divided into seven stages.

915. 1st. The earlist effect of loss of blood consists in a contraction of the blood-vessels. This is universally true of all modes of abstracting blood.

In leeching, an impression is first exerted upon the organic properties of the extreme and capillary vessels of the part by the direct abstraction of their natural stimulus, the *pabulum vitæ*, as also by the long-continued suction of the leeches, and by the subsequent effusion of blood. These causes institute a change in the vital state of the vessels (§ 189, 498, 930).

916. 2d. A vital contraction follows immediately, as the consequence, in the extreme and capillary vessels of the part to which leeches are applied. The removal of their natural stimulus is necessarily felt by the highly-susceptible organic properties of the small vessels (§ 189, 931, 935 *b*).

917. 3d. Then follows, by continuous and remote sympathy (§ 498, 500), a propagation of the foregoing changes to the entire system of extreme and capillary vessels throughout the body. This arises from the capillary series possessing, every where, an organization and function of a common nature, and from their exquisite sensitiveness to the nervous power (§ 129 *d*, *e*, 141, 222–232, 482, 525, 526 *a*, 935 *b*).

918. 4th. The larger vessels, sooner or later, participate, sympathetically, in the contraction. This sympathy, however, begins as soon, at least, as the general capillary system feels the foregoing influences.

919. 5th. A partial sympathetic impression begins upon the heart as soon as the changes have somewhat advanced in the capillary vessels to which the leeches are applied, and a rapidly-increased amount of this cardiac influence ensues as soon as the whole capillary system is involved in the contractions which the leeches institute at the place of their application.

The effect, as expressed in section 917, is originally propagated along the extreme vessels by continuous sympathy, but remote sympathy is soon brought into operation, when both modifications concur together; but it is chiefly through remote sympathy that the heart is influenced (§ 933).

920. 6th. Such are the simple elements of the processes which take place in leeching. But, during their progress, they become more or less compounded. The sympathetic influence which is propagated from the extreme to the larger vessels reacts from the latter upon the former, and this reacting sympathy increases the contraction of the small vessels. So, also, as soon as the vital changes in the extreme vessels throw their sympathetic influence over the heart, the changes which take place in this organ reflect back a sympathetic influence upon the extreme and capillary vessels, by which their power over the heart and larger vessels becomes multiplied (§ 514 *h*, &c., 526 *a*, 934).

This complex, or double circle of sympathies, continues to advance till the heart becomes overpowered in its action, and syncope takes place.

921, *a*. 7th. An artificial change being instituted in the extreme vessels to which leeches are applied, where the organic properties are most strongly pronounced, and that change being more or less permanent, it continues to exert a powerful sympathetic influence upon the whole capillary system, and thence upon the heart, long after the blood has ceased flowing (§ 514 *g*, &c., 516 *d*, no. 6, 939).

921, *b*. It is for this reason (no. 7), and this only, that the powers of the general circulation may be sometimes more prostrated, and be longer maintained in a state of prostration, by the loss of four ounces of blood by leeching, than they might have been by the abstraction of sixteen ounces of blood from a large vein, or by eight ounces taken by the process of cupping (§ 514 *g*, 930).

921, *c*. For the same reason, also, syncope sometimes comes on only many hours after the discharge of blood has ceased. Stimulants, too, may but slowly rouse the general circulation, because the prostrating influence of the artificial change in the extreme vessels cannot be as soon overcome as when syncope is produced by general bloodletting, where no such specific impressions are made (§ 514 *g*, 516 *d*, no. 6).

922, *a*. It is owing to the peculiar nature of the change established in the vital condition of the extreme vessels, by leeching, that the blood continues to flow out for many hours. The process thus instituted must be somewhat analogous to that of secretion, and clearly allied to the hemorrhagic action which nature institutes, though generally more prostrating than the natural process.

922, *b*. There is, however, a remarkable difference between the direct effects of leeching and spontaneous hemorrhage, in respect to their force; the former subduing inflammation and congestions more fully and speedily than the latter. It is rare that an equal quantity of blood spontaneously effused impresses the system with a force equal to that from leeching; while large capillary hemorrhages are daily occurring without very sensibly reducing the animal or organic powers, and where, too, the quantity of blood effused is so prodigiously great that it cannot be safely imitated by art under the same circumstances of disease.

Although, therefore, in these cases, nature institutes a change strikingly analogous to that of leeching, it is not of the same specific nature. In spontaneous hemorrhage, too, nature sets up, for her own safety, as it were, a special modification of action in the system at large that shall sustain its powers under the enormous losses of blood which are often necessary, by the natural process, to the cure of inflammatory and congestive diseases (§ 136 *c*, 150–152, 524 *a*, no. 3, *d*, 890 *e*).

923, *a*. Besides the foregoing play of vascular sympathies, a strong impression may be propagated by the whole organ to which leeches are applied, to another organ with which it has strong natural sympathetic relations. In low inflammations and venous congestions of the liver, four ounces of blood taken from the verge of the anus by means of leeches may break up those obstinate hepatic affections, when twenty ounces from the skin over the region of that organ may produce far less effect. Here the specific impression is propagated, in part, along the mucous tract of the intestines, in the manner expressed in sections 498, *f*, *g*; remote, as well as continuous sympathy, being brought into operation by this general impression on the mucous tissue.

923, *b*. But, again, it is true in a more limited sense, that the influence of leeching may be propagated along the large blood-vessels to the parts in the vicinity, where there is a direct vascular communication; though even in these cases, the impression is extended more through the sympathies which bind together the extreme vessels, and the nervous communication of the parts (§ 526, *a*). Comparatively little seems to be due to the imputed derivation of blood. Thence, upon our principles, appears the reason why, according to Dr. Wardrop, "in diseases of the head, as well as in diseases of the eye, more particularly those affecting the internal parts of the globe, leeches applied to the frontal vessels give much more relief than is obtained by abstracting an equal quantity of blood from the temporal vessels by leeches applied to the temples." He also states that a like advantage will be obtained, in cerebral affections, by applying leeches to the lining membrane of the nose, or behind the ears. He thinks the effect greater than when applied to other parts.

923, *c*. In all the cases, however, the effects appear to be mainly produced through the agencies which I have stated. Whenever I have applied leeches to the nasal septum, abdominal disease attended the

head-affections. The leeches have sometimes relieved the headache, when general bloodletting, cathartics, &c., had failed, while the gastric derangement had also persisted. But, simultaneously with the relief of the head, the secretions from the bowels improved, the tongue cleared up, and the stomach and other abdominal organs were relieved. It would appear, therefore, that, as in the case of leeches to the verge of the anus under similar circumstances, the specific impression of leeching the nasal septum is propagated continuously and by remote sympathy, through the instrumentality of the mucous membrane, to the viscera of the abdomen, and that the head is as well relieved by thus removing this source of morbid sympathies, as by the more direct impression.

923, *d*. Hence it follows, as shown also by experience, that leeching will generally exert the greatest effect upon diseased organs when applied to some part with which the organ affected may have strong physiological relations (§ 129, 139, 140). For this reason, and for the advantage of continuous sympathy, leeches should be applied to the anus in muco-intestinal inflammation; but, to the cutaneous region when inflammation affects the peritoneal coat of the intestines or abdomen. There are greater natural sympathies between the skin and peritoneum, than between the mucous membrane and the peritoneal. Where no remarkable relations subsist among organs, the leeches should then be applied near the vicinity of the part affected, as when the pleura, or parenchyma of the lungs, or the joints, are the seats of inflammation. In such cases we obtain the advantage of contiguous sympathy, as in the case of blisters, &c. (§ 497).

924. And now a word more as to the doctrine of ***Revulsion***, or that, for example, which supposes that when leeches are applied to the feet for the relief of cerebral disease, the effect depends upon the diversion of blood from the head toward the feet. And so of cathartics in their action upon the intestinal canal, and of blisters by diverting the blood to the skin, &c. (§ 893, *n*). Nothing can be more unfounded. But, do not leeches, when applied to the feet, exert a greater influence upon diseased conditions of the uterus than upon any other part? They probably do; and it is a forcible illustration of remote sympathy, and coincident with that which is supplied by the suspension of the catamenia from exposure of the soles of the feet to cold, or by the production of catarrh when a current of cold air from a key-hole impinges upon the neck. Just so, if the female now plunge her feet into warm water, or apply leeches upon or near the soles of the feet, the catamenia may be restored. So, too, in relation to cerebral affections, who does not know that a natural sympathy subsists between the feet and the head? "In affections of the head and thoracic viscera," says Dr. Wardrop, "I have, in many instances, recommended patients to apply leeches on the head, chest, and on the feet, alternately; and *almost universally*, I may venture to say, a decided preference has been given to the *feet*." The philosophy is the same in all the cases, and revulsion is nothing but sympathy. Dr. Wardrop, however, had already preferred the application of leeches to the nasal septum, or to the temples, in affections of the head; though his observations as to the feet are also founded on sound experience. As to leeching in amenorrhœa, the remedy has the greatest effect when applied to the perinæum, or to the upper part of the thighs.

925, *a*. What has been now said of disease supposes that leeches are applied under circumstances favorable to their effect. Before this condition can happen, however, in numerous cases where leeching may be ultimately useful, it may be necessary to make a strong impression by general bloodletting; and if two or more general bloodlettings be likely to be wanted, the leeching should be delayed (§ 893 *g–i*, *p*, 927).

925, *b*. Nevertheless, if the chance of leeching alone be taken in these cases, the number of leeches should be very large for adults, that the benefits of general bloodletting may be more or less obtained, through a rapid and copious abstraction of blood. This practice will often succeed in infants, when it will fail at more advanced age; since the loss of blood is more sensibly felt in the former case, and less is required, and the requisite amount is therefore, also, more rapidly abstracted, notwithstanding, too, the ratio of the loss, in proportion to age and size, may be actually greater than in adults. Thus, too, the advantages of general bloodletting are more or less obtained. In similar cases, cupping is also more beneficial to children than to adults (§ 576, *e*).

925, *c*. Leeching, or cupping, however, should never supersede general bloodletting in the cerebral inflammations and congestions of infants. In the phlegmatic temperament of adults, leeching may answer where it would be inefficient in other temperaments (§ 600). But I speak of these cases rather to illustrate a principle, than to raise any doubt as to the propriety of general bloodletting in the grave visceral inflammations of any age (§ 961, *c*).

926. Experience teaches that frequent and small abstractions of blood by means of leeches is often more beneficial in chronic inflammations, than a greater quantity at more distant intervals. This corresponds with what I have said of the vital influences of leeching, and of the effect of habit in maintaining disease (§ 549, 560). In these cases, the impression, being frequently repeated, maintains the salutary change which may be produced, more perfectly against the morbid influence of habit, than greater losses of blood at distant intervals (§ 514 *g*, 535, 540, 542, 548, 549, 557). We see the same principle more frequently exemplified in the effect of blisters upon chronic inflammation; where it is better to apply them frequently, and to a moderate extent, than more rarely and over a larger surface. The philosophy is the same, also, in respect to the relative effects of a large dose of calomel, and that dose divided into four. Analogies likewise subsist between the salutary effects of copious leeching, extensive vesication, and a large dose of calomel, in acute inflammations (§ 559, 893 *h*). And so of numerous other agents. A common philosophy obtains in all the cases, and each example illustrates and confirms the principles on which all other agents operate. And I may here carry the same examples to illustrate the philosophy of the operation of general bloodletting, and the peculiarities which appertain to that mode of abstracting blood; since, as will appear, its influence on the organic properties and functions is more immediately, and may be more profoundly, felt than leeching or other agents; and, being antiphlogistic, it is therefore better adapted to high grades of active inflammation and fever (§ 557). It throws back its light, also, on the modus operandi of the other agents.

927, *a*. Notwithstanding, therefore, the last proposition in respect to leeching, it often happens that the force of diseased habit is so great as to demand a more decisive and more frequent resort to leeching. It is even not unfrequent that the force of morbid habit attendant on chronic inflammations requires the previous abstraction of blood from a vein, and perhaps repeatedly and largely; not only with a view to the special physiological influences of general bloodletting, but that a large diminution of the general volume of blood may be suddenly effected (§ 925, *a*). The utility and necessity of this practice are frequently seen in the treatment of those chronic inflammations of the mucous tissue of the stomach which follow long-protracted indigestion, and especially if the liver also have become invaded by the same condition of disease. The advantages of general bloodletting in these cases relate as much to the general condition of the system over which a morbific influence has been established as to the seat of inflammation. The general modification exerts a reacting effect upon the part inflamed, and adds to the obstinacy of the diseased habit of the part, and leeching will not reach these influences (§ 143 *c*, 847 *g*). Here it is, particularly, that we witness corresponding, and even more successful, efforts of nature at relief, in the torrents of blood that are effused from either the mucous tissue of the stomach or of the lungs; especially the former (§ 890, *e*).

927, *b*. Again, in certain mild, though obstinate cases of purely local inflammations, and before the constitution is brought under the influence of the morbid action; or, in cases where the constitutional disturbance has been subdued by general bloodletting, local bleeding by leeches is pre-eminently useful. In either of these cases, general bloodletting continued to a large extent, by the suddenness and violence of its impression, may so disturb the system at large, that the inflammation may be kept up by influences produced by this artificial derangement of the whole system (§ 889 *m*, 889 *mm*). But here there is no countervailing action against the effect of leeching; and while the small vessels engaged in the inflammatory process refuse to give way if the disease have been of short duration, there is no danger of establishing any injurious influences upon the general capillary system. This, however, will take place, more or less, when leeching exceeds that degree which is necessary to determine a change in the part inflamed. It may even follow from very copious leeching in acute chronic inflammations, where morbid action is rendered obstinate by the influence of habit, before the diseased process yields. In the former case, the system is injured partly by the influences determined by the excessive change induced in the instruments of morbid action, and, in part, by the general influence from an unnecessary loss of blood. In the latter case, the bad effects appear to be mainly incident upon the loss of blood in its general relation to the system at large. In these cases, therefore, it is important to graduate the extent of leeching by the exigencies and the peculiarities of each individual case; and it is especially important with infants, upon whom leeching produces not only its peculiar effects very powerfully, but, also, more than in after life, the effects that appertain more strictly to general bloodletting. Such is the obstinacy of the depressing change in the instruments of disease, or wherever leeches may be applied, in infancy, when this remedy has been carried far beyond any useful de-

gree in inflammations of the nature now under consideration, and its influence upon the whole extent of the circulatory organs is maintained with such violence, that having also superadded to it the general effect from excessive loss of blood, it may be impossible to counteract its destructive tendency (§ 514 *g*, 516 *d*, no. 6). It is not alone the effect that arises from an excess of general bloodletting with which we now contend, but a greater, perhaps, in that pernicious change which has been induced in the extreme vessels to which the leeches had been applied, and which, indeed, has been, more or less, sympathetically propagated over the system (§ 921).

928. From what has now been said, the reason is apparent why cautious leeching is one of the best means of relief in those inflammations that are now and then induced by a misapplied or an excessive loss of blood. In these rare affections, the triumph of art is beautifully illustrated when accurately guided by the light of science. There should not be one drop of blood too much, nor one too little. They are cases, too, in which the distinction between general bloodletting and leeching is forcibly shown, since the former has caused the disease and the latter cures it.

2. GENERAL BLOODLETTING.

929. In general bloodletting, the effects are varied from those of leeching, and in a way, as we have already seen, of practical importance (§ 927, 928). Its influences may be considered under five general aspects:

930. 1st. The earliest impression is made *simultaneously* upon the organic properties of the large and small vessels throughout the body, since the loss of blood is now immediately coextensive with the whole circulating mass, is suddenly withdrawn, and in a comparatively large quantity. Here, therefore, as of the local vessels in leeching, a change is instituted in the vital state of the blood-vessels throughout the body (§ 526 *a*, 915, 921).

931, *a*. 2d. The foregoing impression suddenly rouses the arterial system to a greater, but very modified action, by which the vessels, especially the extreme and capillary, are brought into a state of contraction, and far beyond any diminution of their contents that may arise from the quantity of blood removed from the body (§ 916).

931, *b*. The contraction thus instituted is vastly greater in the small than in the large vessels, mainly because of the greater endowment of the former with irritability and mobility (§ 188, 205, 482).

932. 3d. Owing, also, to the same causes through which the extreme vessels feel the loss of blood more sensibly than the larger ones, powerful sympathetic influences are determined upon the former by the changes which take place in the larger series of vessels (§ 920).

933. 4th. As soon as the foregoing change begins in the vessels, it throws a sympathetic influence over the heart. There is, as yet, so little diminution of the general volume of blood, that the earliest influences upon the action of the heart must be due, entirely, to sympathy (§ 919).

934. 5th. As the heart becomes influenced, it reflects a powerful sympathetic impression back upon the extreme and capillary vessels; between which and the heart there exist very strong vital and sympathetic relations (§ 385, 526 *a*, 920).

Here, therefore, as in leeching (§ 920), the contraction, and other changes, which take place in the small vessels, grow out of a double influence; namely, that which is exerted by the direct impression from loss of blood, and that which is reflected upon them by the changes that arise in the heart and larger vessels. And so, as in leeching, the play of sympathy between the heart and blood-vessels passes and repasses, and increases in an increasing ratio as the blood flows from the arm, till its prostrating effect reaches the point of syncope. In leeching, however, the sympathies between the heart and blood-vessels are not as reciprocal as in general bloodletting; but a greater influence, in the former case, is exerted by the small vessels upon the centre of circulation (§ 921).

935, *a*. That the failure of the heart's action does not arise, as commonly supposed, from a mechanical diminution of the volume of blood, is shown by the frequent occurrence of syncope from the loss of two or three ounces; nor does it depend, in the least, upon withdrawing the stimulus of blood from the heart. On the contrary, as it respects both hypotheses, the blood is actually accumulated about the heart, in consequence of the contraction of the capillary vessels; and this accumulation, from the beginning, is a cause of the failure of the heart's action, and is at its greatest extent when syncope takes place (§ 936).

935, *b*. It is also equally true that the general contraction of the small vessels, in all the modes of abstracting blood, is not referable to either of the foregoing causes; and for the reasons, in part, that the contraction far surpasses any diminution of the general volume of blood, that the phenomenon is always attendant on syncope arising from moral causes, and that the contraction, if proceeding from elasticity or from any other cause than one of a vital nature, could never determine the powerful sympathetic influences which it exerts upon the heart (§ 916, 917, 932, 937).

935, *c*. In like manner, the diminution of the volume of blood in inflamed parts is only a remote effect of lessening the quantity of the circulating mass. The blood is not only temporarily, but permanently expelled from the injected vessels. This shows that its expulsion is effected by a vital change in the condition of the vessels; otherwise, they would not contract in a ratio exceeding that of the corresponding vessels of other parts, nor would their contraction be permanent. Vessels that are enlarged in inflammation to many times their natural diameter are often reduced to nearly their natural volume while the operation of bloodletting is in progress (§ 910, 977).

Various circumstantial facts might be adduced to show the vital nature of the contraction which attends the capillary vessels. The following are relative to idiosyncrasy; and the principle which I have set forth is an evidence of the accuracy of the reporter's interpretation of the phenomena, throughout. Thus: Dr. Paige, "of large experience and great respectability," states, in the November number (1845) of the "New York Journal of Medicine," that, on bleeding "a woman about forty years of age, and after having drawn a very few ounces, and while the blood was still flowing from the vein, she was taken with very severe pain all over the external parts of the system, and extending to the most remote extremities. I suffered the blood to flow, however, but the pain increased instead of diminish-

ing." "Several years afterward I met with exactly the same symptoms on bleeding a young man in case of an ardent fever; but, having thought much of the first case above mentioned, I had come to the conclusion, in my own mind, that the pain depended on the *spasmodic contraction* of the small vessels of the surface and extremities as they became emptied of their blood. I, in this case, immediately administered a free dose of some diffusible stimulus (I think, of ammonia), and the pain subsided very soon, so that I was able to take as much blood as I wished" (§ 399).

935, *d.* Again, bloodletting being, in popular language, a debilitating remedy, its rapidly salutary effects contradict the prevailing hypothesis that inflammation and venous congestion are constituted by debility of the vessels, and stagnation of blood. Had this doctrine any foundation, the capillaries, in inflammation, and the veins, in congestion, would immediately become more injected with blood, and those diseases should be exasperated by what is known to be their most efficient remedy.

The effects of bloodletting, therefore, prove that the pathological cause of inflammation and venous congestion consists not only of an increased energy of the organic properties, but that these properties are also modified in kind; while the rapid subsidence of the foregoing affection, under the influence of loss of blood, proves, abundantly, that the whole process advances upon vital principles. The loss of blood so improves the diseased properties, that their pathological state is changed on the instant (§ 137 *d*, 143, 150–152), and they are brought to obey their natural recuperative law so immediately, that the vessels of an inflamed eye contract and disappear while the blood is yet flowing from the arm. And so of all other parts that are concealed from observation.

935, *e.* The extent and durability of this change will depend upon a variety of circumstances; such, for example, as relate to constitution, the nature of the remote causes, and whether, also, the impression have resulted purely from the loss of blood, or, in part, from moral emotions, or from gastric irritation; and it will be often influenced by the *manner* in which the blood may be abstracted, whether from a large or a small orifice, or whether the operation be suspended for a minute and then resumed. Each of these circumstances, also, discloses the nature of the principles upon which loss of blood produces its effects.

936, *a.* When general bloodletting is practiced in health, the action of the heart begins to fail as soon as the vessels begin to contract; but it is the tendency of inflammation to delay or prevent the vascular changes under an equal loss of blood, while, on the other hand, those changes are often promoted by venous congestion, or by numerous adventitious influences, either moral or physical.

936, *b.* Again, it frequently happens, after the action of the heart is more or less subdued by loss of blood, that it speedily recovers its force, on account of the removal of the prostrating influence of some morbid condition, or of nausea, or of mental disturbance, which removal may be suddenly effected even in the case of some depressing form of disease, and perhaps as soon as the blood begins to flow from the vein (§ 938, *b*).

937, *a.* Since the influences of general bloodletting are exerted, from

the beginning, simultaneously upon the whole capillary system (§ 930), the amount and rapidity of the primary change will depend on the suddenness with which the blood is abstracted ; and whenever loss of blood produces a great and sudden contraction of the whole capillary system, however small the quantity, syncope will approach (§ 935).

937, *b*. And so, also, it was found by Le Gallois and Philip, in their direct experiments upon the brain and spinal cord, that the extent of the nervous influence upon the heart, blood-vessels, and alimentary canal, depended, always, on the suddenness of the impression on the nervous centres, and that when most sudden and violent, it was capable of extinguishing at once the functions of life (§ 478, 479, 510, 511).

937, *c*. Now, as will appear hereafter, the sympathetic changes which take place in the heart and blood-vessels, in general bloodletting, depend upon the operation of the nervous power; just as, in the direct experiments by Le Gallois and Philip, the organic functions were variously affected according to the nature of the influences which were inflicted upon the nervous centres. It is, therefore, already apparent that the effects of bloodletting upon disease will often depend much upon the rapidity with which the blood is abstracted. And this important practical consideration points out another difference between general bloodletting and leeching, and why, in the language of Mr. Travers, "syncope is in proportion to the suddenness, rather than the quantity of the hemorrhage." Hence it is that syncope follows from the loss of a smaller quantity of blood when drawn from a large than from a small orifice, or from both arms than when from one.

937, *d*. It is also another important practical, as well as philosophical, consideration, that if the subject be in an erect posture, syncope will follow sooner than in the horizontal, from the greater inability of the heart in the former case to transmit the blood to the brain; and this circumstance, as will appear, should govern us as to the position of the patient.

938, *a*. Again, the ratio, in which the various influences that arise from general bloodletting will succeed each other in disease, will also depend on the existing condition of the organic states, especially of the heart and blood-vessels (§ 143, 149, 150, 152). It often happens that an increased and uniform susceptibility pervades the whole sanguiferous system; and when this peculiar state exists, the abstraction of a very small quantity of blood may instantly determine a paroxysm of syncope (§ 526 *a*, 961).

938, *b*. This proposition, like all the others which are made without qualification, supposes the influences to depend upon the absolute loss of blood, and not to be affected by adventitious causes, such as emotions of the mind, intestinal irritation, &c. When these accidental and transient causes contribute to the prostration of the circulatory organs, they should be carefully noted; since it is commonly important that a certain amount of blood should be abstracted to produce the requisite impression upon disease. In such cases, therefore, it is commonly necessary to go on with the operation, sooner or later, but generally early, after the patient has revived. The prostrating effects of the adventitious causes generally make but little or no impression upon disease ; and the loss of too little blood often adds violence to inflammation and fever by imparting greater energy to the action of

the heart, or by relieving the general circulation when it may be embarrassed by some local venous congestion (§ 988).

3. CUPPING.

939, *a*. Cupping differs in some of its effects from leeching and general bloodletting. Its influences are of an intermediate nature, but are most allied to the latter. It never makes the profound impression upon the vital condition of the parts to which it is applied that is exerted by leeching, and its influences upon the system at large are also less, under equal circumstances. Cupping, indeed, often fails of relief where leeching is speedily efficient. In a general sense, six ounces of blood taken by leeching is probably equal in its curative effects to nearly twice that quantity abstracted by cupping.

939, *b*. In cupping, the blood is abstracted from the larger series of capillary vessels, whose office is probably but little more than to supply the smaller series, in which the organic properties are most strongly pronounced (§ 384, &c.); nor is that action instituted, by cupping, in those vessels from which the blood is taken, that obtains so profoundly in leeching, and upon which no little of the general and local effects depend (§ 921, 922).

939, *c*. The distinction is also explained by the persistence with which the blood continues to be discharged long after the leeches have performed their office, although smaller and fewer vessels are divided than in the operation of cupping, and in which last the blood ceases to escape as soon as the cupping-glasses are removed. All of which is absolute proof that a remarkable change is instituted in the vital condition of the capillary vessels, by leeching, and that the prolonged effusion of blood is in no respect of a mechanical nature, but wholly due to a vital action which is artificially set up in the vessels, and which is not at all instituted by cupping.

939, *d*. It is evident, therefore, from principle as well as experience, that cupping-glasses should not be applied, as is often done, to promote the bleeding of leech-bites. It embarrasses the specific action instituted by the leeches. A mechanical is substituted for a natural process; while, also, as in cupping, the abstraction of blood is so rapid that its effects become more like those of venesection.

939, *e*. Cupping approximates general bloodletting not only in the rapidity with which the blood is abstracted, but in which it determines the great influences upon the whole circulatory system, and in the quantity of blood which is required for its physiological and therapeutical effects. It is more remotely allied to leeching in the change which is locally induced, though this change is not of a specific character, but consists of a more simple vital contraction of the small vessels that propagates comparatively little impression upon other parts of the circulatory system. When the impression becomes general, it is then mostly due, as in venesection, to the removal of a quantity of blood adequate to a universal influence.

939, *f*. It becomes more and more apparent, therefore, that general bloodletting, cupping, and leeching are in some respects distinct remedies, and that cupping is the least useful and rarely required. The difference between them lies in a difference in the operation of the principles which are common to the severel modes. Some of these differences appertain to the cerebro-spinal system, which is far more

concerned in the phenomena of general bloodletting than in the usual effects of leeching, at all stages of the operation. It appears, however, that the effects of general bloodletting may be obtained in an inferior degree by cupping, through more inconsiderable degrees of the same influences, as, also, in a still lesser degree by applying cupping-glasses in the operation of leeching; though, where leeching is appropriate, it must be often at the expense of a greater loss of blood, and at a loss, more or less, of the specific effects of leeching.

Of the Nervous Power in its Relation to the Effects of Loss of Blood.

940. Another important element in the phenomena which arise from loss of blood must now be considered. This is the nervous power, to which are owing all the remote sympathies that are in active progress after the beginning of the constitutional effects of bloodletting. The operation of this power commences at the earliest contraction of the small vessels, and increases in the ratio of that contraction. It is the same power that exerts so vast a range of influences in directing the effects of all other remedial, as well as morbific agents, and whose characteristics have been already extensively considered. The same philosophy, too, is here applicable as in all other cases in which the nervous power is instrumental in organic actions, or in modifying, or in propagating disease (§ 222–234, 450–530).

941. The development of the nervous power from loss of blood is owing to the vital contractions of the small vessels of the brain and spinal cord, and to the necessary antecedent change in the vital condition of the vessels of those parts (§ 931, 935). An influence is thus exerted upon the nervous centres analogous to that which we have seen to arise from direct experiments (§ 476–494), from the operation of the passions (§ 227, 230), and from remedial and morbific agents (§ 227, 500).

942, *a*. Now, therefore, in view of the extensive premises before us, loss of blood, by establishing a universal contraction of the small vessels of the nervous centres, and by its sudden impression upon the organic properties of those centres, develops the nervous power in a peculiar manner and in unusual intensity (§ 227, 232). This influence of this power, reflected abroad, increases that contraction of the general capillary system which is at first instituted, in all parts, in general bloodletting, by the direct effect of loss of blood upon the organic properties of the whole system of blood-vessels (§ 930, 931).

942, *b*. In leeching, the first sympathetic influences are propagated continuously from the part to which leeches are applied (§ 498), but are soon extended to the brain and spinal cord, the nervous power excited, and spread abroad over the system, as in general bloodletting (§ 464, 465, 500 *b*). The general contraction of the vessels is thus more and more accelerated as the loss of blood goes on, the nervous power is more and more excited, and prostrates the action of the heart; and this in an increasing ratio as syncope approaches.

942, *c*. There is not, therefore, as has been universally supposed, a withdrawment of the nervous influence from the heart during a paroxysm of syncope; but, on the contrary, an increased determination of that power upon the organs of circulation, which, indeed, is then at its acme.

943, *a*. Again, it has been shown by Le Gallois, Philip, and others,

that the stomach and intestines are readily and powerfully influenced by impressions made upon the central parts of the nervous system (§ 491); as they also are, like the heart, by mental emotions. As soon, therefore, as the vessels of the nervous centres begin to contract, the nervous influence is felt as well by the stomach as by the heart and blood-vessels. This gastric irritation is propagated back to the brain and spinal cord, and increases their depressing influence on all the organs. This is especially manifest immediately before the occurrence of syncope, which it contributes to hasten. Hence, also, the frequent nausea and eructations, and the intestinal evacuations, which supervene on the contraction of the cerebral and spinal vessels, or as syncope approaches (§ 902, *g*). It is for this reason that cathartics often operate during the operation of general bloodletting, when they had failed antecedently, and where no intestinal inflammation had existed to interfere with their effects. And this consideration, by-the-way, is important to the practitioner when he is deliberating whether bloodletting should precede the exhibition of a cathartic or an emetic.

943, *b*. But, it is also true that the intestinal disturbance is often owing to the effect of nervous influence excited by some emotion of the mind (§ 892$\frac{3}{4}$, *b*); when its reaction upon the nervous centres may be equally as great as when the disturbance results from the loss of blood, but has little or no effect upon disease, and may embarrass the practitioner, and sacrifice the patient to an imperfect application of the remedy (§ 938). Nevertheless, it is important to say that exceptions sometimes occur; and when such demonstrations are made, they yield the most convincing proof of my doctrine of the agency of the nervous power in the physiological results of bloodletting, and its alterative influence upon disease by whatever cause the influence may be excited. Thus: "A patient," says Dr. Armstrong, "was so alarmed at the preparation for bleeding, that syncope occurred, and completely stopped an inflammation of the pleura." Again, "cheer up the patient, and he is always sure to do well" (§ 227–230, 232).

944, *a*. When syncope arises from the depressing emotions, or from other causes whose primary impression is upon the brain, the action of the heart is directly prostrated through the nervous influence, and indirectly by its sympathy with the stomach; while a certain depressing effect is exerted by the nervous power upon the extreme and capillary blood-vessels, and an influence from this change is propagated sympathetically to the heart. The succession of changes then, as respects the heart and blood-vessels, begins more on the side of the heart than when they are determined by loss of blood; the contraction of the capillary vessels being also more consequent on the failure of the heart's action than on the alterative influence of the nervous power. We must also explain, in the foregoing manner, the syncope which follows blows upon the stomach, the crush of limbs, surgical operations, &c.; and when death is *suddenly* produced by any of these causes, it is owing either to a sudden extinction of the cerebro-spinal functions, or to a powerful determination of the nervous influence upon the heart, &c., by which the action of that organ is arrested (§ 230, 480 *b*, &c., 510, 511). The same is true of the prostrating effects of nausea, and many other accidental influences which spring up during the operation of bloodletting.

944, *b*. Since, therefore, in the case of bloodletting, its influences

are profound, not only on the instruments of disease, but upon the whole capillary system, and the failure of the heart's action is greatly due to this deep impression on their vital constitution, while in the case of the accidental causes the effect consists mostly in a direct depression of the heart's action, and a consequent failure of supply to the capillary vessels, without essentially affecting their vital states, it is obvious that we may not depend on syncope as a test of the influences of loss of blood (§ 959).

944, *c*. Is it asked why the failure of supply to the capillary vessels when the heart is suddenly depressed by the foregoing accidental causes is not even more efficient in disease than the artificial method of abstracting blood from the same vessels? I answer, summarily, that it depends on the nature of the exciting cause, and on the universal law of adaptation, which is every where conspicuously designed for the preservation of organic beings (§ 137 *c*, 150, 151, 733 *d*, 847 *g*).

944, *d*. Syncope is often consummated by removing the ligature. In this case the action of the heart had been enfeebled almost to an accession of the paroxysm, and the additional quantity of blood suddenly thrown upon the heart, so far from rousing the organ, overpowers its action. It is in this way, in part, when the heart has been gradually prostrated during the access of congestive fever, that a sudden development of the attack sometimes produces syncope. Something, however, is evidently owing, in this case, to the sympathetic influence of the extreme vessels upon the heart, but probably more to the sudden determination of blood from the circumference at the access of the cold stage.

945. If syncope be obstinate, the means of relief will be such as operate through the medium of the nervous centres, and should be of such a nature as will subdue the depressing character of the nervous influence, and render it stimulant to the heart and blood-vessels. Pungent vapors to the nose, cold air, cold water dashed upon the surface, stimulants introduced into the stomach and intestine, and exciting means of a corresponding kind, as well as perfect rest, will therefore be the proper remedies (§ 481, *e*).

In the *Medical and Physiological Commentaries*, vol. i., p. 178 (1840), I proposed, in cases of obstinate and alarming syncope, the operation of acupuncturation of the heart; deriving my suggestion from Marshall's experiments upon frogs, which were revived by that process when apparently dead from carbonic acid. Very lately (1843), I see in the *Annali Universali di Medicina*, that Dr. A. Carraro has successfully repeated these experiments, and makes the same application to the human subject as had been done by myself. The whole is also commonly supposed to be original with Carraro.

When syncope supervenes, if the subject be laid in a horizontal posture animation returns, and it may be again suspended by reversing the position. These phenomena depend upon causes now essentially modified. "No man ever saw the sensorial functions continue a single minute after the heart had ceased to move. When the body is horizontal, the heart circulates the blood more easily, than when any part, and especially so large a part as the head, is elevated." If syncope return when the head is again elevated, it will depend on a more simple cause than what originally produced it. It will now arise from a permanently enfeebled state of the heart, and "its ina-

bility to continue the circulation, and thus to supply the brain and all other parts with blood;" and such is always the last in the series of causes, in a paroxysm of syncope. In the first instance, the action of the heart is prostrated through the nervous influence of the brain and spinal cord; in the second, the functions of the brain are impaired or suspended through the enfeebled action of the heart.

946, *a*. Many examples may be found in my Essay on the Philosophy of the Operation of Loss of Blood, which show the great alterative nature of the nervous power as developed by bloodletting. Let one suffice at present. Thus: "A patient," says Dr. Armstrong, "having lost only an ounce of blood, from the shock of the operation syncope came on, and effectually removed an acute inflammation of the brain" (§ 943).

946, *b*. Examples of the foregoing nature admit but one interpretation. They are clear illustrations of the peculiar properties and laws by which organic beings are governed. They are simple elements of the whole philosophy of which I have spoken, as it respects the specific nature of the properties and actions of life, of their mutability, and of the tremendous influence which the nervous power is capable of exerting upon them. It is the same, also, when life is instantly extinguished by a drop of hydrocyanic acid, or of the alcoholic solution of the extract of nux vomica, applied to the tongue, or by a blow on the epigastrium, by surgical operations, &c. (§ 177, 222, &c.).

947. The philosophy of syncope, as expressed by M. Piorry, has been the philosophy of no small part of the medical world; while all the antecedent influences of bloodletting have been more universally referred to the mechanical diminution of the circulating fluid, and syncope construed upon this doctrine.

"*Syncope*," says the eminent Piorry, "*whatever may be its cause, consists in a suspension or diminution of cerebral action. If it take place spontaneously and from a moral cause, it is the action of the encephalon that is suspended; it is the influence of this organ upon the heart which is diminished.*"

We have seen, however, in the ordinary state of the body, that the nervous system has little other influence upon the organic functions than that of contributing to their concert of action; these functions being all carried on by the organic properties, which are maintained in operation by stimuli peculiar to each, but mostly by the blood. The nervous power becomes a stimulant, or depressant, or modifying cause, to the organic and animal functions only when it is preternaturally affected by physical and moral causes (§ 177–191, 223, 226, 227, 232, 476, &c.). It is also fully demonstrated that the entire removal of the brain and spinal cord does not affect the action of the heart, if respiration be artificially maintained (§ 477, 479, 481 *h*). Nay, the heart often continues to pulsate long after its removal from the body (§ 489 *e*, 516 *d*, no. 7). When we consider, also, how powerfully the heart may be influenced by slight mechanical or other agents applied to the brain, or spinal cord (§ 480, &c.), even when the cerebral circulation is destroyed, and the whole inferior portion of the organ removed, we shall better understand, in this way, how loss of blood, odors, offensive sights, and moral causes, produce syncope, than by supposing that it is through their direct suspension of the cerebral

functions. Violent passions have, doubtless, the effect of extinguishing, at once, the powers and functions of the brain; but then the action of the heart ceases at once, and is clearly owing to the sudden death of the brain, while in syncope the action of the heart is only diminished. Nevertheless, even in the former case, a pernicious nervous influence is suddenly determined upon the whole circulatory system (§ 479, 509, 510). Again, it is only the depressing emotions, like fear, grief, disgust, and such causes as in any degree exert a sedative influence on the circulation, that are known to produce undoubted syncope, while those like joy and anger, which always excite the action of the heart, alone extinguish life instantaneously. One affection, too, is common, while the other is rare; and when the latter takes place, it is probable that there exists an apoplectic predisposition. In one case, the action of the heart is suddenly depressed; in the other, it is powerfully excited. Doubtless, too, in the latter instance, the violent impulse of the blood upon the brain contributes, *per se*, to the sudden extinction of the cerebral powers. While, therefore, in syncope, from fear and grief, the blood is, at the onset, diverted from the head; in sudden death from joy or anger, a preternatural quantity is determined upon the brain.

948. It appears, therefore, that the various changes which take place in the action of the heart, when they arise from loss of blood, are chiefly dependent upon the nervous influence, or remote sympathy, and that this influence is greatest when syncope ensues (§ 481, *h*). Nor is there at any stage of that complex series of changes, from the first impression that follows the loss of blood to their end in syncope, a deficiency, but a redundancy, of blood at the centre of circulation; and, if death ensue, the vital fluid is always found accumulated in the cavities of the heart.

949. Summarily, also, we have now seen that it is the effect of loss of blood, *per se*, to so modify the vital states of the capillary blood-vessels as to result in their contraction, and that when this contraction begins in the vessels of the nervous centres, it excites the nervous influence in proportion to the extent and suddenness of the impression; that this influence is then propagated abroad, and increases the contraction of the capillaries at large; that this effect of the nervous influence is reflected back upon the nervous centres, by which the nervous influence is still farther excited; that circles of sympathy become thus established; that the nervous influence is now, also, exerted with a depressing effect upon the heart, and intestinal canal, and that this effect is thrown back upon the brain and spinal cord, by which the intensity of the nervous influence is farther increased; that the play of sympathies, and the multiplying causes of nervous influence, become, therefore, exceedingly complex, and increase in their ratio till the heart is prostrated by that influence and by the central determination of blood, when syncope takes place as an immediate consequence (§ 476½ *h*, 481 *h*).

But, we have also seen, that if too little blood be taken, in certain conditions of disease, results of an opposite nature to the foregoing, and an aggravation of disease, may ensue, though they will be brought about through the same physiological principles (§ 965, 983–989).

And now I say, if the foregoing results of loss of blood be com-

pared with the effects of other remedial or morbific agents, it will be found that a close analogy and harmony of laws distinguish their modus operandi. And such is always the simplicity of nature in her fundamental institutions (§ 137 *e*, 150–152).

950. From what has been now seen of the profound influences of bloodletting upon the nervous centres, especially when syncope approaches, we readily account for those inflammations, and that far overrated irritation of modern physicians, which occasionally supervene on the loss of blood (§ 1020–1023); sometimes, though rarely, from an excess of the remedy, but more frequently from its deficiency, and still more so from its frequent application in small quantities where a greater loss is demanded. If the loss be excessive, or bloodletting not appropriate to the case, a sudden and violent impression is made by the nervous power upon the capillary blood-vessels. When the loss is small and frequently repeated, an irritable state of the whole vascular system is thus established, which may not only increase the inflammation which the remedy was intended to subdue, but may become the foundation of disease in other parts (§ 476½ *h*, 479, 965 *b*, 982–1001, 1005 *e*).

In all these cases, the whole system of capillary blood-vessels has a large share in the primary impression; but a peculiar influence is determined upon them by the violence inflicted on the extreme capillaries of the brain. Inflammation, therefore, may be lighted up, as a consequence, either in the brain or some other part, but especially the brain (§ 230, 231). Hence, also, the general vascular excitement, and that delirium, coma, stertorous breathing, and those convulsions, retchings, and involuntary intestinal evacuations; some of which so frequently follow excessive loss of blood. Although bloodletting, therefore, be a remedy for inflammation, the excessive use of it, as will be farther shown, may induce that affection; and even then, the cautious abstraction of blood by leeches still proves, by its curative influence, the nature of the affection, and the sanative power of the remedy when well directed (§ 901, 997).

951, *a*. Let us now regard the foregoing morbific effect of loss of blood (§ 950) in connection with two examples, one of coincident, the other of an opposite, nature, to show the effect of the nervous power upon the capillary vessels of all parts, as illustrative of this agency in the operation of bloodletting. It will be observed that they conform to the experiments of Philip on the brain and spinal cord (§ 476–492). Thus:

"It is certain," says Müller, "that nervous influence is the principal cause of the accumulation of blood in the capillaries of certain parts during the state of vital turgescence." "In the instantaneous injection of the cheeks with blood in the act of blushing, and of the whole head under the influence of violent passions, the local phenomena are evidently induced by the nervous influence. The active congestion of certain organs of the brain, for example, while they are in a state of excitement, is a similar phenomenon."

These several examples, however various may be the remote causes of the phenomena, are so nearly alike that they may be regarded as one, and it is not less obvious that they equally correspond with that of inflammation when induced by excessive loss of blood.

951 *b*. And now for the opposite result, which is brought about

by precisely the same immediate exciting cause, the nervous influence.

"When a patient," says Dr. Armstrong, "had lost only an ounce of blood, from the shock of the operation, syncope came on and effectually removed an acute inflammation of the brain." Again, "a patient," says the same writer, "was so alarmed at the preparation for bleeding, that syncope occurred, and completely stopped an inflammation of the pleura."

951, *c*. Looking at the foregoing examples in their true relations, there may be advantageously considered, besides their immediate object, certain other points which reflect a strong light upon the nature of the nervous power, the causes and mode of its development, its modifications by the nature of its exciting causes, its subsequent propagation to parts remote from the brain and upon the brain itself, and its remarkable influences upon all parts. In the examples before us we see that power variously and in unusual operation. We see that it is positively developed by excessive loss of blood, by shame, by the violent exciting passions, producing a high arterial action, or inflammation of the brain or of other parts in one case (§ 950), instantaneous injection of the cheeks with blood in another, and the brain and whole head in another (§ 951, *a*); and these are corresponding results. We see, also, that an exactly opposite effect is produced by the loss of only one ounce of blood, and in another instance by the operation of fear alone (§ 951, *b*); an acute inflammation of the brain being overthrown in the former case, and an inflammation of the pleura in the latter. The common nature of the immediate cause cannot be mistaken; and when we consider the variety of more remote exciting causes, excessive loss of blood in one case, an ounce in another, shame, anger, and fear in others, the close analogies, yet diversified results, in one series of the cases, and the absolute opposition in the other series, yet each example in this series exactly alike, though involving the loss of an ounce of blood in one of the instances and fear in the other; when, I say, we consider these things, we must not only admit the common nature of the immediate cause, but that this cause is liable to be variously modified by the agents which rouse it into action, and that, however apparently estranged from each other may be many of these agents, they modify the immediate cause in modes corresponding with the effects. A common philosophy applies, therefore, to all the cases, and this philosophy is equally true of those morbific and remedial agents which determine the same effects upon distant parts when applied to the alimentary canal, or to the skin, &c., and therefore, also, of the whole compass of remote sympathy. The type of the whole is in the examples before us.

951, *d*. It is farther worthy of remark that the examples (§ 951, *b*) show how powerfully the nervous influence may be determined upon the organic constitution of the brain by the loss of a single ounce of blood, and in the case of the pleuritic inflammation by fear alone; while either case is a conclusive proof of the philosophy which I have propounded of the modus operandi of bloodletting, and that it is in no respect of a mechanical nature. These examples also demonstrate my position that the nervous influence is most profoundly felt when syncope comes on.

952, *a*. Some of the finest illustrations of the effect of bloodletting

upon the organic properties of the extreme vessels of the arterial system, either directly through the loss of blood, or, indirectly, through the nervous power, are shown by the changes which take place in the blood while flowing from the arm in inflammatory diseases.

952, *b*. Some of the most remarkable of the foregoing changes may be induced by a very small loss of blood. Thus, a patient of mine was attacked with pneumonia, after convalescence had begun from a protracted fever. She was placed in an erect posture, and an ounce of blood was drawn, in a full stream, into each of three wine-glasses; when syncope took place. In the first glass, the blood had a thick, strong, indented, buff, and a fimbriated edge; in the second, the buff was sensibly less, and the other peculiarities were diminished; in the third, they had disappeared.

952, *c*. On the contrary, however, in a case of inflammatory fever, Hewson observed the unusual phenomenon of the appearance of the inflammatory buff only on the fourth cup.

952, *d*. "There is a very considerable difference to be sometimes observed in the quantity of coagulable lymph in blood taken in different cups from the same patient at the same bleeding. In some instances, this difference has been observed nearly one half."—Wardrop. Sometimes more than one half.—Scudamore. "The same is relatively increased during the continuance of bleeding; and it is surprising how great a change will take place in this respect at minute periods."—Thackrah. And so Gendrin, Stokes, &c. Again, however, the foregoing phenomena are sometimes directly reversed; and an increased quantity of fibrin, and a diminution of serum, have been found in each successive cup. These conditions, too, as well as the preceding, depend, in a measure, upon the rapidity with which the blood is abstracted. Mead, the able humoralist of other days, observes, that "the blood may certainly undergo any imaginable changes by alterations made in its motions only."

952, *e*. If syncope take place, the blood not only generally loses its inflammatory characteristics (*b*), but the clot is often much softer and more voluminous. Should the inflammation afterward go on, the blood will be found to have resumed its former peculiarities.

952, *f*. Blood, drawn from a person, or from an animal about to faint, coagulates very rapidly. In this case, the rapidity of coagulation appears to bear a remarkable ratio to the depression of the organic properties of the solids; as may be readily seen in slaughter-houses. But, again, on the other hand, when death is suddenly produced through the nervous system by blows on the stomach, apoplexy, &c., or by running, lightning, organic affections of the heart, &c., or when the powers of life are greatly reduced by malignant fevers, the blood remains fluid.

These seeming paradoxes are resolved by supposing peculiar influences of the solids upon the blood, according to the specific modifications of their organic properties; these, as well as all the other differences and changes, being, therefore, an evidence that bloodletting produces its effects upon the *vires vitæ* of the solids, and that the organic properties, other things being equal, will be affected according to the quantity of blood taken, the manner of taking it, &c.

952, *g*. Musgrave, in adverting to the rapid changes which take place in the blood during the operation of general bloodletting, re-

marks that these alterations "require the agency of some third power; for to suppose that the blood undergoes so sudden a change merely by the quantity being lessened, would hardly be more extraordinary, than to imagine that pouring a glass of brandy out of a bottle would turn the rest into cider."

952, *h*. How futile, therefore, the recent observations of Andral as to the relative quantity of lymph in inflammatory diseases! The blood to be inspected must be drawn from the subject, and the loss of one or two ounces may affect, essentially, the proportion of lymph in the next two ounces, and so on. Here, therefore, is proof in the very nature of things, which stamps all these inquiries as humoral assumptions. Indeed, Andral, himself, had long before settled the fallacy of these later observations, by the well-grounded statement, in his Pathological Anatomy, that "no one solid can undergo the slightest modification without producing some derangement in the nature and quality of the materials destined to form blood, or to be separated from it." And this, too, from the father of modern humoralism (§ 688, *e*).

GENERAL AND PRACTICAL OBSERVATIONS ON BLOODLETTING.

Of the General Extent of the Remedy.

953. The vital influences of loss of blood are owing to the vital relations of the blood to the organic properties of the solids. The blood being the *pabulum vitæ*, the solids are extremely sensitive to any loss of this fluid they may sustain. This sensitiveness resides in the organic properties (§ 184, &c.). Inflammation and fever being also essentially constituted by a morbid condition of those properties (which are more susceptible for being thus affected (§ 137 *d*, 143 *c*)), the loss of blood, especially in general bloodletting, makes an instantaneous and profound impression upon them, by which their morbid condition is so radically altered that nature steps in at once, and sometimes completes the cure almost on the instant (§ 137 *e*, 151, 152).

954, *a*. There can be no general rule as to the quantity of blood which should be abstracted in any given case of disease, or as to the rapidity with which the abstraction should be made. This must always depend upon the circumstances of each individual case, and upon the effects of the remedy during its application, which should, of course, be superintended by the physician (§ 675).

954, *b*. It is, nevertheless, certain, in a general sense, that some definite quantity of blood should be removed; and this, according to the nature of the affected organs, the character and intensity of the disease, &c. (§ 133–156). This is necessary not only to the present effects, but to the permanent influences of the remedy. This permanence cannot often be maintained without the continued operation of a certain diminished supply of blood to the general capillary system (§ 514 *g*, 516 *d*, no. 6). Dry cupping, therefore, and all similar expedients which are prompted entirely by erroneous views of the modus operandi of loss of blood, produce none of the effects which appertain to bloodletting in any of its modes. I cannot, therefore, accede either to the dry cupping of the distinguished mechanical physician, Dr. Arnott, or to his opinion "that it is a great modern improvement in the practice of the healing art, in bleeding for the cure of inflammation, to take the blood away *as quickly as possible;* since

intense inflammations of the brain, lungs, bowels, &c., are equally removed by faintness, whether it happens after the loss of two ounces of blood, or of fifty."—ARNOTT'S *Physics, &c.*

954, *c.* In general bloodletting, the nearer the loss is carried to the point of syncope, the more profound and permanent will be its effects. In grave forms of inflammation and fever this amount of influence is required, and perhaps at repeated applications of the remedy (§ 999).

954, *d.* When syncope is induced by loss of blood alone, it is a test that the vital condition of the small blood-vessels has been strongly affected; but more or less so, in a general sense, in the ratio of the quantity abstracted. Like the contraction of those vessels, syncope is one, though a less simple, consequence of the vital impression exerted upon them.

955, *a.* It should be said, therefore, in qualification of the statement in section 951, *b*, that it is exceedingly rare that the loss of a single ounce of blood, by venesection, will subvert inflammation of any organ, especially of the brain, even though the nervous influence be so intensely developed as to establish syncope (§ 961, *c*). The following are common examples, and go with the others to illustrate my doctrine of the nervous influence. Thus, Dr. Armstrong:

955, *b.* "A patient, at the point of death from acute inflammation of the pleura and lungs, was bled to the extent of fifty ounces, when he had obtained no relief. If we had stopped here, in two hours the patient would have died. After abstracting about six ounces more blood, syncope came on, from which he recovered convalescent."

If this patient had been bled in an erect posture and from both arms, and had syncope followed the loss of fifteen or twenty ounces of blood, it is scarcely probable that he would have been saved.

Again, another patient of Armstrong's "had been once bled, after which the inflammation of the pleura and lungs returned. He had nearly expired from the bleeding; but the symptoms were so urgent that I determined to bleed him decisively, and I told his friends that he might perhaps even die under the operation. I bled him decisively, and syncope came on suddenly and continued some time, so that I thought he would have died. He recovered afterward with small doses of calomel and opium" (§ 892$\frac{4}{5}$, *i*).

955, *c.* Examples of the foregoing nature have been of constant occurrence, in the hands of enlightened understanding, from the time of Hippocrates, who began the example. The proper rule in extreme cases was observed, as above, by Armstrong, and was thus laid down by Celsus: "It may happen," says Celsus, "that a disease may require bloodletting, when the system seems unable to bear it. Yet, if there appear no other remedy, and the patient must perish unless relieved by a rash attempt, it is then the part of a good physician to declare that bloodletting is the last resource of his art, but that it may precipitate death. Having done this, he should bleed, if desired. There can be no room for hesitation in cases like this, since it is better to try a doubtful remedy than none at all. And this ought especially to be done, when a paroxysm of fever has nearly destroyed a patient, and another equally severe is likely to follow. So, also, in palsy, and, again, when angina suffocates" (§ 892 *c*, 892$\frac{4}{5}$ *i*).

955, *d.* Here the importance is fully shown, not only of abstracting a certain quantity of blood, but of obtaining a full impression from the

cerebro-spinal influence, in many cases of inflammatory affections, as, also, the error of Marshall Hall's recommendation that "bloodletting should never be carried to actual syncope, but only to the very first signs of approaching syncope, which is, in fact, to be prevented by immediately laying the patient in the recumbent position." Many examples of the foregoing nature are presented in the *Commentaries*, and others will follow in the present work.

955, *e*. Where bloodletting has been already carried to a large extent, yet the original disease still perseveres; or when we are called at the advanced stages of inflammation or fever, or where inflammations may spring up in subjects exhausted by long confinement, or in broken-down constitutions, the rules of practice are less precise, and depend more upon the circumstances of each individual case. But, in a general sense, so long as any severe or obstinate inflammation may be present, whether acute or chronic, we shall scarcely go wrong in abstracting more or less blood, and often largely, either by the lancet or by leeches. This is the dictate of philosophy, and it is enforced by the soundest experience. They are often cases, however, which demand habits of critical observation, often much experience, and an unremitting attention to medical pursuits. It will be often, otherwise, but little better than the hazard of the die. Without these requisites, where uncertainty prevails in critical conjunctures, it is better to leave the whole matter to nature. In such emergencies, she will oftener triumph than the unskillful practitioner, who may only embarrass her efforts. "*Medici plus interdum quiete, quam movendo, proficerunt.*" This principle holds in the foregoing cases where art is imbecile from ignorance. And so it is from inadequate bloodletting in the early stages of inflammation and fever.

But, let it be remembered that the two most important objects to be considered in the treatment of disease is,

1st. *To adapt our remedies in all respects to the nature and existing condition of the pathological states.*

2d. *To carry them as far as, and no farther, than the institution of such a change as will enable Nature to take upon herself, most successfully, the work of cure* (§ 857).

956. General bloodletting is the proper mode of depletion, especially after the age of infancy (§ 576, *e*), in all forms of fever, and in all the active inflammations of the internal viscera. This is particularly required at the beginning of the treatment, on account of the universal change which general bloodletting induces in the sanguiferous organs; thereby relieving, at once, the instruments of disease of a redundant quantity of blood, and immediately reducing the force with which the blood is distributed. There is also thus obtained a farther important advantage from the powerful sympathetic influence which is determined upon the instruments of disease by a great and sudden change of action throughout the arterial system, as well as from influences exerted upon the general vital conditions of numerous organs; the very effect upon the skin, for example, and especially upon the intestinal canal, throwing a general influence upon other organs which may be the seats of disease; just as when antimony or ipecacuanha send their influences abroad in a more direct manner through the intestinal mucous tissue, or call up the co-operation of the skin with that tissue in subduing pulmonary inflammations (§ 514, *h*).

957. On the other hand, if the treatment have been begun by other remedies, or if it have been neglected, and disease have thus acquired the force of habit (§ 539), or if general arterial excitement have existed and gone down spontaneously, or, in neglected cases, under the influence of remedial agents, even of loss of blood, and however suddenly, the results in the preceding section can only be obtained in an inferior degree by general bloodletting. Comparatively little change of action may then be induced in the vessels generally; or the effect of general bloodletting may be lost in the influence of habit (§ 539, &c.). Here, too, the remedy is on a par, in principle, with all others. Nevertheless, general bloodletting is likely to be important at any stage of visceral inflammation, so long as the disease exists in much intensity; whatever treatment may have been pursued, or however the disease may have been neglected. But, should a manifest abatement have followed under any of the foregoing circumstances, leeching may then become far more efficient than venesection (§ 892$\frac{4}{5}$ *i*, 1008).

958, *a*. In the ordinary forms of active inflammation, and where practicable in fever (§ 961–970), the first bloodletting should be the largest, and this should be in proportion to the exigencies of the case. We may often accomplish all that is desirable by a single blow, as it were; which is incomparably better, in grave inflammations and fevers, than a dozen smaller ones, which may even fail, or prove detrimental, in the end, where greater decision, at the onset, would have completed a cure (§ 950, 965).

958, *b*. It appears, also, from what has been said, that the operation of general bloodletting should always be conducted by the physician; and it is doubtless owing to disappointments that have arisen from consigning the application of this important remedy to the hands of barbers and leechers, that it has fallen into disrepute with many. Leeching may be done by the unprofessional, because it operates upon a modified principle from that of general bloodletting; and it is much less important as to the precise quantity of blood which should be abstracted.

But, in general bloodletting, every thing may depend upon an exact effect at the moment of the operation; and that will depend not only upon the precise quantity of blood abstracted, but upon the position of the patient, the size of the orifice, the flow of the blood, the management of the patient's mind, so that moral emotions shall not interfere, and upon other well-regulated influences which the skillful physician can alone determine, and alone estimate. Nor can the most experienced and gifted practitioner ever foretell, in any given case of disease, what quantity of blood should be abstracted, by the general method, under the best-regulated circumstances.

This practice of intrusting the operation of general bloodletting to the ignorant will cease to be tolerated when the *modus operandi* of the remedy shall come to be appreciated and acknowledged; nor, until then, will it undergo in the hands of the professional that just application, according to the exigencies of disease, which rarely fails to illustrate its remedial effects.

958, *c*. I must now refer the reader to those divisions of my subject where the distinctions are considered between leeching, general bloodletting, and cupping, for other remarks relative to the just quantities of blood that should be abstracted in certain given forms of dis

ease, and which were there introduced for the purpose of illustrating the distinctions between those several modes of bloodletting.

959, *a*. Finally, therefore, from what has been now said of the principles upon which bloodletting operates, as well as from experience, the rule as laid down by Dr. Marshall Hall, and other late writers, that "*Syncope is a uniform criterion of the quantity of blood to be abstracted, and which the nature of the case may demand*," is fallacious. Dr. Wardrop gives us the same rule. "The state of fainting," he says, "is to be considered an index of the quantity of blood which is necessary to be removed for the *relief* of the disease." On the contrary, syncope may depend on so many other causes than loss of blood, the actual tolerance, at the first operation, may be so little, that its repetition may be indispensable soon after the patient revives, and perhaps to a large extent even before binding up the arm. These cases of early syncope, where the remedy may be appropriate, are, also, the very ones which most demand repeated abstractions of blood; *and the effect produced at each application of the remedy should be the measure of the quantity to be abstracted* (§ 682 *c*, 688 *d*, *e*, 936–938, 943, 944, 961, 967, 981–988).

959, *b*. "Dr. Moseley," says Robert Jackson, "advises us to bleed, *ad deliquium*, in yellow fever. I coincide with him in recommending extensive bleeding in this form of disease; but I do not accede to the rule which he assumes for judging of the measure. It is vague and uncertain. Deliquium occurs sometimes from the loss of a few ounces of blood, sometimes scarcely from the loss of six pounds. The act of fainting is not, therefore, a rule of dependence for regulating practice" (§ 992, 994).

960, *a*. Many expedients have been attempted as substitutes for bloodletting; from the comparatively rational method by cathartics, blisters, and other subordinate antiphlogistics, to the ne plus ultra of dry cupping. It would be difficult to assign their appropriate rank, in theoretical conceptions, to some of the novelties which have been brought forward, from time to time, to fulfill, or to surpass, the intentions of bloodletting, or to banish this principal remedy from the healing art. Louis undertook its explosion with more signal success than any other champion of the "meditation upon death." (See *Examination of the Writings of M. Louis*, in *Med. and Phys. Comm.*, vol. ii., p. 679–815.) Others, more inclined than Louis to lend a helping hand to nature, resort to bold experiment, whose evil results, if incident to bloodletting, it must be allowed, would consign this remedy to a well-merited reproach. Thus Pereira, in his Materia Medica, remarks that,

"*I tried tobacco somewhat extensively, a few years since, as a substitute for bloodletting in inflammatory affections. But, while it produced such distressing nausea and depression, that it was with difficulty I could induce patients to persevere in its use, I did not find its antiphlogistic powers at all proportionate, and eventually I discontinued its employment.*"

Such, then, is the philosophy which rears itself against the well-tried and faithful agent; while it is regardless, by its own showing, of the disastrous results of agents long since condemned as fruitless and destructive, and would vainly endeavor to "substitute" them for the safest and only effectual remedy for all grave inflammations.

When Pereira undertook to "substitute tobacco for bloodletting in inflammatory affections," it was with the full knowledge that its use had been mostly abandoned, as wanting in curative virtues, and hostile to life; that surgeons, even, had greatly forsaken it as an enema in strangulated hernia, on account of the frequent deaths it had produced (§ 892¾ *l*, 893 *n*). It was mainly such diseases as confirmed dropsy, tetanus, intractable ileus, and hydrophobia, that were handed over to its tender mercies. Nay, more; our able author says of it, himself, as employed for the relief of dropsy, that,

"In small doses, it is an uncertain diuretic, and in larger doses it causes such a distressing nausea and depression, that practitioners have *long since* ceased to use it in dropsical cases."

How many perished under the experiment with this unmanageable poison, in Pereira's attempt "to substitute it for bloodletting in inflammatory affections," either from the direct effect of the poison, or from the neglect of bloodletting, our author does not say; though confessions here would have been some atonement to science and humanity.

Nor may the contemners of bloodletting, and of those who commend its judicious use, in the treatment of inflammations, complain when "their poisoned chalice is thus commended to their own lips."

Were we to contrast the victims of tobacco, alone, during its rage as a panacea, with such as may be assumed to have fallen, through all time, by the lancet, it will not be denied by the stoutest prejudice, that the odds are fearfully on the side of the poison. It is profitable, therefore, to pursue this inquiry, and to interrogate yet farther the disposition which may exist in the most enlightened quarters to hold on upon the worthless, but deadly engines of the Materia Medica. The tendency may be, at least, to induce a greater toleration of the useful means, and thus to compensate, in a measure, for the effects of poisons, when administered in what are regarded as their therapeutical doses.

We may, therefore, consult another eminent writer of our own day, the able author of the *American Medical Botany;* though he does not say, nor have we reason to think, that he had "attempted to substitute tobacco for bloodletting in inflammatory affections." I make the quotation, therefore, to show how there will sometimes escape from the best writers and practitioners an apparent justification of the worst practices humanity is called upon to encounter; and to contrast the tacit experience of all in commendation of poisons which operate with deadly effect in their authorized doses (so only they be administered by the stomach, that galvanic trough of the Chemist), with the denunciations of bloodletting which are wafted from transatlantic shores to startle Americans into mute astonishment. Thus, then, our author:

"At the present day," he says, "tobacco does not seem to be extensively in use, having passed into neglect rather because more fashionable remedies have superseded it, than because it has really been weighed and found wanting."

In this respect, the able writer is manifestly at fault; and if we only turn over this same leaf from which I have made the quotation, we shall read on the next page as follows:

"This powerful medicine has been also employed with some palliative effect in hydrophobia, and certain other spasmodic diseases. Its internal use, however, requires great caution, since patients have

in various instances, been destroyed by improper quantities administered by the hands of the unskillful or unwary. Notwithstanding the common use and extensive consumption of tobacco in its various forms, it must unquestionably be ranked among narcotic poisons of the most active class. The great prostration of strength, excessive giddiness, fainting, and violent affections of the alimentary canal, which often attend its internal use, make it proper that so potent a drug should be resorted to by medical men, only in restricted doses, and *on occasions of magnitude*."

Here, then, we are justly told that tobacco should be used with caution even in hydrophobia. And, suppose it could be said of bloodletting, as the writer affirms of tobacco, that "patients have, *in various instances*, been destroyed by improper quantities," even though a part of the injury might be ascribed to "the hands of the unskillful and unwary;" the advocates of the remedy would scarcely allege, on seeing it fall into disuse, what the foregoing writer does of tobacco, that "it has passed into neglect rather because more fashionable remedies have superseded it, than because it has really been weighed and found wanting." No; they would acquiesce upon the ground that it "had been weighed and found wanting." And now suppose, again, that such "weighing and wanting" could be truly affirmed of bloodletting, as is conceded, in reality, by the best advocates of tobacco, even in the hands of the best practitioners,—in their own hands,—or only through ignorance and carelessness alone, the remedy would be so hunted down, that the rational treatment of inflammations and fevers by bloodletting would probably subject the practitioner to public odium. Indeed, we know that this was remarkably the case with the illustrious Robert Jackson, when he first began the explosion of the tonic and stimulant treatment which prevailed so fatally in the British Army. He was generally denounced as "a murderer" by the British Doctors; till the astonishingly diminished mortality in the British Army soon showed them who the real murderers were (§ 569, *e*). On the other hand, however, with what calm indifference we contemplate the ravages of the tonic and stimulant treatment of fevers, and the no less inconsiderate use of the most violent agents of the Materia Medica, for the mere purpose of devising some expedient that shall do away with the necessity of bloodletting in acute inflammations and fevers!

As to tobacco, in the treatment of strangulated hernia, we possess in tartarized antimony, or even in the lobelia inflata, far better and safer means for establishing a relaxation of the muscular system; especially in the former agent. Nay, in very many cases, bloodletting, to the extent of syncope, will not only accomplish the intention as fully, but bestow the immense advantage of subduing any inflammation of the intestine, which is so apt to be produced by strangulation. Besides the immediate hazard of life which is incident to enemas of tobacco, there is the great objection, that should it fail of its contemplated purpose, the prostration which it occasions will render an operation by the knife of very doubtful result, but which might have been perfectly safe before the administration of the tobacco. The patient will be little apt to bear the superadded shock which is inflicted by so severe an operation; and the intestine, too, in a state of inflammation which will now contribute greatly to the same general ex-

haustion. And since the question, among surgeons, has turned mainly upon the abstract effect of tobacco as an agent of *immediate* death, and without much reference to those ulterior results, and since it is no proof that a remedial agent does not destroy because the patient survives its immediate operation, I may also say that its pernicious tendency reaches these cases in the obstacle which it places in the way of subsequent bloodletting, which is often important to the patient soon after the reduction of the intestine, if it have not preceded it (§ 576, *e*).*

But, it is not alone this or that agent, or other individual means, which has been attempted as a substitute for bloodletting in the treatment of inflammations. The whole class of poisonous agents, to which tobacco belongs, has been declared on high authority, as we have seen (§ 891, *c*), to be "the most important medicines we possess." And to justify yet farther what I have said of British therapeutics, and to sustain the contrast with American philosophy and practice (§ 349 *d*, $350\frac{3}{4}$ *k*, *kk*, 709, *note*), I shall quote Pereira's *Materia Medica* relative to his opinion of opium when compared with the uses of bloodletting, cathartics, antimonials, &c.

"*Opium*," he says, "*is undoubtedly the most important and valuable*

* The fascinations which attend tobacco as a luxury led to its extensive use as a remedy for disease; and the question arises whether, from what is now known of its pernicious effects when applied to the gastro-intestinal mucous membrane, and even to the skin, in health as well as disease, its moderate use as a luxury can be justified by the physician? This question I shall briefly investigate, for another purpose, also;–that of illustrating yet farther certain peculiarities of remedial agents in relation to vital habit (§ 535, &c.).

There could be little doubt, upon principle, that the various modes of using tobacco would be detrimental in most conditions of disease, on account of the increased susceptibility of organs (§ 137 *d*, 150, 151). But it would be still a question of facts in relation to this particular agent (§ 650). The requisite facts are before us, and are decisive against the luxury in morbid conditions.

But, this does not prove that the moderate use of tobacco will injure the health of those who are in possession of health (§ 137, *d*). We cannot reason, as I have endeavored to show, from the effects of remedies upon man in health to man in disease; excepting as it respects their violence when manifested in healthy subjects. Of this principle tobacco affords a very full exemplification, and shows that the principle is equally true in its opposite aspect, and that we may not reason from the effects of an agent which is deleterious in disease to its effects under the condition of health; as, indeed, is shown by food itself.

We must, therefore, take the facts in all the cases, and what other facts teach us as to the constitution and laws of organic beings, and as agents operate upon different parts. With this kind of philosophy, we are enabled (unexpectedly, according to the usual method) to decide that the moderate use of tobacco is rarely deleterious in health, and has, therefore, but little, if any, tendency to abbreviate life. The law of vital habit, as well as observation, enable us, also, to know that the habitual, is safer than the interrupted, use of tobacco; so, only, there be no excess. The insusceptibility, which the continued use establishes, soon passes off on suspending the influence, and leaves the individual more or less liable to nauseating and other morbific effects, on resuming the luxury. If this be often repeated, it would probably lead to chronic or other forms of disease (§ 535, &c.).

There is, therefore, a remarkable difference between the ultimate effects of the habitual use of tobacco and of most other poisonous agents of the Materia Medica. The narcotics, for example, are constantly morbific, while continued in their moderate therapeutical dose, though less so by use than at the beginning. But this is not true of many of the ordinary causes of disease, which observe a coincidence with the effects that arise from the habitual and interrupted use of tobacco. The miasmata which lay the foundation of fever are examples (§ 544, 550, 551, 552 *a*). This brings into view the differences in the vital constitution of different parts of the mucous system, and the examples are clear illustrations of those distinctions; since, in the case of the poisonous agents of the Materia Medica (including tobacco), they exert their influences upon the mucous tissue of the stomach and intestine, while tobacco, as a luxury, and miasmatic agents, are mostly operative upon other parts. The same is seen in the skin, since tobacco will not establish the habit of endurance in that organ (§ 136, 137 *b*, &c.). Tobacco is also another witness, in its associated aspects as a luxury and as a poison, against the doctrine of operation by absorption.

remedy of the whole Materia Medica." "Its good effects are not, as is the case with some valuable medicines, remote and contingent, but they are immediate, direct, and obvious; and its operation is not attended with pain or discomfort. Furthermore, it is applied, and with the greatest success, to the relief of maladies of every day's occurrence, some of which are attended with the most acute human suffering. These circumstances, with others not necessary here to enumerate, conspire to give to opium an interest *not possessed by any other article of the Materia Medica;*"—and certainly not by bloodletting.

And now suppose that the Author of these Institutes had made the same affirmation of opium, instead of having bestowed the like commendation upon bloodletting in his former work; he would have cheerfully acquiesced even in the misrepresentations of his *Commentaries* by the British Medical Press, and in the countenance afforded by the British Medical Profession of the great injustice inflicted upon himself, as an atonement for the injury he might have done.

Nor did I scarcely do justice to the cause which I endeavor to advocate, when, in a former section, I spoke of the influence of the British "Association" in their concerted action to overthrow the fabric of Medicine, and to raise upon its ruins the absurdities of a foreign Chemist (§ 349, *d*). The record should have been also made that the work on "*Organic Chemistry applied to Physiology*" had been a year before the Profession, ere its successor, the work on "*Animal Chemistry applied to Pathology and Therapeutics,*" was "*communicated to the British Association for the Advancement of Science,*" and "*Edited* FROM THE AUTHOR'S MANUSCRIPT, BY WILLIAM GREGORY, M.D., PROFESSOR OF MEDICINE *in the University and King's College,*" and before other distinguished British medical writers became the systematic INTERPRETERS of the Author's *meaning*, as well as Champions of his nonsense (§ 350½, 350⅔, 447½ *f*). The hurricane, I say, swept over the Nation, and such was its force upon the Continent, and even in America, that the learned in those Countries had serious doubts of the stability of any science, and that the great bulwarks, which had been slowly and progressively reared by the observation and wisdom of a long series of ages, would be, hereafter, at the mercy of any aspirant. For all this, the British Nation must and will be held responsible.

And now, let us remember, that when radical and enduring changes may be wrought in any science which is built upon the foundations of Nature, and when, especially, the phenomena have been open to all, they will hereafter advance as slowly, at least, as the errors had sprung into existence. The wisdom of one generation is, at most, but a shadow in advance of the last; and, however discoveries may come up in the open field of Nature, the great laws which have been educed from what was known in the past will be of no easy subversion. Nor can I doubt, that come what may to Medicine, we shall sooner or later go back to Hippocrates, and begin a reconstruction upon the foundations which his genius and observation had laid.

Developments of important facts in science and in art may advance with rapidity; but, even those details, which are apt to grow out of principles already known, are commonly progressive according to the sum of knowledge which may be handed over by one generation to the next succeeding. It is not, however, equally true, that a portion,

or the whole of mankind, relapse into ignorance, speculation, and superstition, through the same gradual process. The decline of the Roman Empire, and the subsequent darkness which overshadowed the earth for six hundred years, or the later fall of Spain from the highest to the lowest rank among the nations of Europe, are a melancholy commentary upon the rapid and disastrous influences of luxurious ease, and arbitrary opinion, upon knowledge and philosophy, and illustrate the tardy pace of the human mind in regaining its independence, recovering the path of Nature, and retrieving what it has lost. Nor is it an improbable conjecture that the serious failure of a harvest in Europe, or any serious impediment to the outlet of British manufactures, or an ascendency of *Puseyism*, would soon place our Ancestor by the side of Spain.

But, practical examples in bloodletting are the best demonstrations of the utility of the specific objects contemplated in the present article. I shall therefore supply another, which may be derived from the distinguished Mr. Liston, so able in surgery, and who advises,

"*Every practitioner to think twice of the probable and possible effects in every case of disease before he determines upon and proceeds to open a vein for the purpose of draining off the vital fluid.*"

This distinguished surgeon also recommends the use of *aconite* for the cure of erysipelas (§ 892½, *d*). Just now, also (1845), Dr. Fleming (President of the Royal Medical Society of Edinburgh) appears with an able work on the same most destructive agent; and, although agreeing with him, most entirely, as to the value of this remedy in neuralgia, when topically applied, and there be no active inflammation, every consideration of experience is opposed to his declaration, that,

"*Aconite not only effects a cure in a shorter period than any other mode of treatment, in acute rheumatism, but appears to possess the great negative advantage of not increasing the liability to extension of the disease to the membranes of the heart.*"

The great difficulty with bloodletting in acute articular rheumatism has consisted in its too limited application; and if the remedy, as is said, be chargeable with the vice of lighting up the disease in the heart, it is for the foregoing reason (§ 893 *n*, 950, 965, 1000, 1001). Bouillaud is thought to have occasioned no little of this mischief by "copious bloodletting," and mainly because of his expression,—"coup sur coup." But, he rarely ventured beyond a pound or two of blood; and this quantity was made up by successive bleedings,—"coup sur coup." His practice, therefore, was but a feeble resuscitation of that far more successful treatment, in France, by copious abstraction of blood.—(*Med. and Phys. Comm.*, vol. i., p. 325, 326.)

Finally, I hold that the internal use of aconite is inadmissible in all active forms of inflammation, and endangers life under all circumstances of health or disease. Had Dr. Male, of Birmingham, who employed this remedy to the extent of some eighty drops of the tincture in four days, in augmented doses varying from five to ten drops, for the relief of simple, chronic pain in the back, from the recommendation set forth in the work by Dr. Fleming, been as obviously the victim of bloodletting as he was of the aconite, it can hardly be doubted that such a case would have been marshaled against bloodletting in all forms of disease.

Nor will I neglect this opportunity of objecting to the proposition

of Dr. Graves, of Dublin, that belladonna, instead of bloodletting, should be employed in those congestive fevers in which cerebral disease is attended by contraction of the pupil, and upon the ground, mainly, that belladonna so affects the brain as to produce a dilatation of the pupil. It is evident, however, that this reasoning is fallacious; for, if belladonna be given in any of the common forms of cerebral disease, that disease will be aggravated in proportion as the pupil dilates under the influence of this agent. In justice, also, to the remedy which I advocate, I may say, if its applicability rested on no better foundation, and if, especially, surrounded by the same objections as belladonna, its recommendation would be justly regarded as rash and unphilosophical (§ 469, 476 *c*, 487, 488½, 500 *h*, 569, 892 *d*, 906, motto, *d*).

960, *b*. It may be also difficult to say, whether the mere negative pretext for loss of blood, such as dry cupping, or the substitution of violent internal agents without a plausible apology, or the more common and exclusive dependence upon cathartics, and other acknowledged but minor antiphlogistics, has been most destructive of life. Certain it is, however, that they who most discourage bloodletting are generally the greatest advocates of the violent agents of the Materia Medica. And, it is not a little astonishing with what calm indifference we contemplate the ravages of this unmitigated practice, or the tonic and stimulant treatment of fevers; and more especially when the consequences are alienating multitudes to the soft embraces of homœopathy (§ 857, 878, 893 *n*).

960, *c*. I have already stated my opinion that, among the sequelæ of morbid anatomy as originally taught by the modern Parisian school, and adopted by others, is the system of "*Specialities*;" a name sufficiently significant of its dismemberment of medicine. To this partial philosophy of a comprehensive science, whose parts can be no more separated, and viewed in the abstract, than any one of the great organs of life can be separated from the rest, and yet go on with its own functions and the residue of the shattered whole with theirs, may be traced up many of the great errors in practice as well as in medical philosophy (§ 129, 137 *e*, 163, 638, 685, 686). That the "*special*" system was an immediate emanation from the hospitals of Paris, is evident not only from the natural relations of the pursuits, but from the fact, also, that they sprung up together. Nature thus became disjointed; every thing in disease took on the aspect of materialism; nothing was to be seen but lesions of structure within, and blotches and scabs upon the surface; one kind of fever was located in the liver, another in the spleen, and dropsy in "Bright's disease of the kidneys." Medicine was cut up, in the Parisian hospitals, into numerous fragments, and brought under all the details of the mechanical principle of "a division of labor." The practical results which have followed upon an extensive scale require no farther exemplification. But, it is also to the same system, in part, that we must ascribe the attempts of a smaller number to substitute tobacco, belladonna, aconite, &c., for bloodletting, in the treatment of inflammation and fever; and it is upon this ground that Magendie was led to imagine that he had produced, in the presence of his class, yellow fever in dogs, and typhus fever in cats (§ 744), and which, especially, has induced many to believe in the matchless virtues of quinia as displayed by Piorry

when he attempted the dislodgment of intermittent fever from an indurated spleen (§ 892, *k*).

960, *d.* But, it is not alone the intrinsic nature of the fundamental evil which has introduced the new system of teaching medicine. There never was a time when so many zealous aspirants were commended to *places* either by clamors, or by the force of industry. The revolution was also only a part of the fashion of the day; and its precipitation harmonized exactly with the achievements in medical chemistry, and other analogous varieties in the wide field of philosophy. Fortunately, this corruption has not yet fastened itself upon the Medical Colleges of Great Britain or America; and the hope may be therefore entertained that the worst of it has passed (§ 1008).

960, *e.* Nor will I leave the foregoing allusions to the comparative value and abuse of the great agents for disease, without referring to the general apathy which is manifested at the havoc which the whole band of empyrics are dealing out with their domestic engines of death; while, were the lancet equally common in their hands, and only now and then a startling slaughter, that solitary result would rouse the indignation of the profession, and disturb the peace of society.

960, *f.* The advocates of bloodletting have sometimes affected its reputation by the mere language in which it is recommended. They are said to be rash; and bloodletting shares the odium. Thus, Dr. Elliotson, in speaking of enteritis, remarks, that "*The first thing one has to do is to bleed the patient well. You must set him upright as he can be, and bleed him from a large orifice without any mercy.*" The prejudiced, or unreflecting, look only at the language; but an upright posture, and a large orifice, render the operation safe, and comparatively mild, though it proceed, as it should, ad deliquium.

960, *g.* I have no doubt that much of the antipathy to bloodletting has grown out of an illusion natural to the fears of man. It is not wholly predicated of debility; for we constantly meet with admonitions against its use in high inflammations, which are not remarkable for their prostrating effect. But, there is nothing more deeply implanted, than the knowledge of the immediate importance of the "vital fluid" to the life of every animal; and this conviction has been farther roused into operation by perverting the authority of Holy Writ, that "in the blood is the life thereof;" though, had Scripture said that in Calomel, Jalap, and Emetic Tartar, or Tobacco, Aconite, Lobelia, and Brandreth's Pills, is the death thereof, the quotation would have been hourly apposite. We are, also, dead in a few seconds from the division of a large artery; and we scarcely see a difference in the rapidity of the result when this method, or a division of the medulla oblongata, is employed for the destruction of life. Hence, many come to associate bloodletting, as practiced for the relief of disease, with the extreme method of effecting death. I shall not dwell upon this want of philosophy, but shall only now say, that it is the same defect which leads the objectors to bloodletting in disease to its constant application to pregnant women, and to others dying of apoplexy, or from the shock of a fall, or from drinking cold water, and where there may have been no other inducement for the practice than the capricious desire of the subject, or the prejudice of society. I shall, however, endeavor to indicate still farther the fallacy of the latter practice, and to point out, as it respects disease, some of the principal causes which

modify the necessities of the system in relation to its ordinary supply of blood, and how it sustains the privation by the same contingent influences.

960, *h*. Let us, finally, have a word upon the doctrine laid down and so well understood by Hippocrates, that, "*Severe diseases require severe remedies*" (§ 906, *motto*, *e*).

From what has been said under the general consideration of Therapeutics, it appears that this rule is to be received in a broad, not a universal, sense (§ 906, *f*). We have seen, for example, that it is remarkably liable to exception in small-pox, &c. This grows out of the nature of the predisposing causes of disease, which alter the properties of life according to the nature of each agent. Each one, as I have said, affects them in *kind*, and in a way peculiar to itself. We have seen this impressively exemplified in the self-limited diseases; and it is shown in the morbific effects of all the agents of the Materia Medica. One will alter the vital states, either in health or disease, more profoundly and more permanently than others. Such, also, is the principle upon which depend the hereditary predispositions to disease. Then we have those dormant changes which constitute the predisposition to idiopathic fever, and which may be in a state of incubation for a year or more before the final explosion.

In all such cases, the properties of life are more or less permanently affected, though not profoundly, till an explosion of more absolute disease shall follow; but often as the result of a long and imperceptible series of morbid changes. In tuberculous phthisis, cancer, syphilis, &c., the properties of life are deeply, as well as more permanently and obstinately affected, and it may be impracticable for art to induce such changes as shall place the diseased states in a recuperative condition.

Then we have the varieties and gradations of febrile and inflammatory diseases, which, according to the nature of the predisposing causes, either yield spontaneously, or submit readily to appropriate remedial agents.

Here, too, we derive important lessons from experience, in a more restricted sense, which go with what experience has reduced to principles in respect to the modifying effects of the remote causes of disease, in establishing the principle that the treatment of disease must be governed by the existing pathological states, and with a reference to the nature of the predisposing causes, and that great modifications may be necessary in diseases of a common genus, though all the cases may be distinguished by equal violence, and by many prominent phenomena that may be very analogous. It is now, therefore, that we find the general rule, that "severe diseases require severe remedies," may demand a great modification (§ 52, 137 *d*, *e*, 143 *c*, 150–152, 163, 650, 666, 670, 673, 674 *d*, 675, 685, 686, 847 *g*, 854 *d*, 856 *b*, 857, 858, 859 *b*, 861, 863, 868 *b*, 870 *aa*).

The application of the rule will depend, I say, in a general sense, upon the nature of the remote causes, the organs affected, and the extent in which the restorative principle is impaired. A vast variety of diseases require no aid from art. Others, again, like pneumonia, enteritis, &c., require a prompt and energetic interference. But, again, there are maladies of great violence, as in the examples already mentioned of small-pox, measles, scarlatina, &c., in which the same

treatment cannot be pursued, in a general sense, as in many diseases whose symptoms are much more violent.

It might, therefore, seem that Nature is here contradicting herself. But it is far otherwise. The apparent contradictions are only illustrations of her perfect consistency, and of the great laws, that morbific causes alter the nature of the properties and functions of life according to the virtues of each cause, and that artificial impressions can be salutary only in proportion as the morbific causes impair the recuperative principle. But, owing to constitutional peculiarities, and various incidental influences, the disposition to the restorative process in the self limited diseases may be more or less impaired, or inflammation of important organs may supervene, when Nature will require the intervention of art, according to the existing modifications and complications of disease. Again, as in the hot stage of fever, the very recuperative efforts of Nature, if I may say so, are often so excessive as to result in actual increase, or in developments of, disease, and therefore require the interposition of art for a certain degree of restraint (§ 675).

Of Bloodletting in the Congestive Forms of Disease.

961, *a*. It often happens that idiopathic fever is attended with venous congestion of one or more important organs; and, as we have seen, it is the tendency of this inflammatory condition of the venous tissue to embarrass the organs of circulation, especially the heart. The same peculiar influences are sometimes witnessed in the inflammations of other tissues; particularly in the advanced stages of phthisis pulmonalis (§ 961, *f*). In all the congestive forms of disease, especially when of an acute nature, the general susceptibility of the system to the loss of blood is increased. I may also say that the prostration which is induced by venous inflammation is quite different from that which results from inflammations of any other tissue (§ 135–137, 140, 150). It is also greatly different from that which attends the cold stage of fever. In the first case, a profound sympathetic impression seizes upon many important organs, and, unless artificially relieved, the powers of life may sink rapidly to a state of extinction. Nature is, as it were, knocked down, and is incapable of a recuperative effort. In the last cases, however, the impression is manifested chiefly in the circulatory system. There is not that profound lesion, in the absence of venous congestion, which prevents the recuperative effort; and hence it probably always happens in pure fever that reaction soon follows the stage of depression (§ 675, 764). Something like the converse of this is seen in those erysipelatous inflammations of the throat which sometimes give rise to an apparently great commotion of the system. But, if there be no great amount of abdominal disease attendant on these cases, the force of the sympathies is expended upon the circulatory apparatus; when any remedy that will relieve the throat will be followed at once by a subsidence of the arterial excitement (§ 140, 927 *b*). But, these cases are apt to be complicated with obscure, though severe congestive disease of the abdominal organs, especially of the liver, which has thrown deeply a morbific predisposition over many other parts, and which, in consequence, feel more profoundly the influences propagated by the intense inflammation of the fauces. In such instances, however, the general arterial

excitement is less than in some of the violent affections of the fauces which may be greatly of a local nature, or where any accompanying abdominal disease may be of a different nature from congestion (§ 689 *l*, 973).

961, *b*. Venous congestion, independent of fever, is a common form of disease, and manifests the same tendency, as when connected with idiopathic fever, to embarrass the organs of circulation. But, this is only a contingent effect; since the general manifestations of the disease in respect to the circulatory apparatus exist in a subdued form of that excitement which attends the ordinary forms of inflammation (§ 390 *b*, 688 *c–k*, 786, &c., 978). But, when venous congestion becomes suddenly aggravated, or other causes may increase the susceptibility of the system so that the congestive disease may be more sensibly felt in its sympathetic influences, there often takes place a general prostration of the animal functions, and a very impaired condition of the organic.

It is, however, in congestive fever that we witness the strong demonstrations of venous congestion in generating extensive and profound lesions of the organic functions throughout the body. This is especially true if the local disease exist at the invasion of the constitutional malady. It has then already shed a malign influence in connection with the predisposition to the general disease; and, as these influences progress together, they come in with intense force when the explosion takes place, and, unless art should now interpose, the diseases go on mutually exasperating each other, and calling into existence other congestions, or inflammations, which make all haste to join in the circles of disordered movements (§ 143, 514 *h*, 666, 902 *g*). The presence of venous congestion not only aggravates the constitutional disease, but, in itself, modifies the *nature* of that affection for the worse (§ 786, &c.), prolongs the stage of intense morbid action (§ 764, *a*), often prevents the succession of the hot stage, and does its own peculiar part in overthrowing the organic functions; nor withdraws its malign influence till subdued by art (§ 927). Here, too, it is that art must make its demands upon science more extensively, more deeply, than in any other conditions of disease. The proper management of bloodletting, cathartics, &c., or whether a stimulant shall be first administered, or whether under the most appalling aspects of the combined force of disease we shall leave all to Nature till she will admit of help, are often problems upon which life is poising at the moment, and can be resolved only by the enlightened physician.

But, it commonly happens that remedial aid may be promptly and efficiently administered; and, it will be my purpose, therefore, to indicate that system of treatment which is demanded in a vast proportion of the cases.

As a preliminary step, I must refer the reader to what I have said of the pathology of venous congestion (§ 786–818), and especially to the *Medical and Physiological Commentaries*, for the proof of the inflammatory nature of venous congestion, and its dire effects upon organic life. It is also important to add, in this place, that although there exist more or less apparent prostration of life in the aggravated conditions of venous congestion, and of active phlebitis, as, also, in congestive fever, the term is here employed in a conventional sense, and not as significant of debility, or of any necessary depression of

vital action. The circulatory organs are, indeed, often more or less sunken in their action; but the immediate instruments by which the morbid processes are carried on are actually exalted in their organic properties. These properties, too, are now greatly diverted from their natural state; and it is that alteration in *kind* which essentially constitutes the local condition of disease, and from which all its sympathetic influences result, and it is this, and the partial loss of voluntary control over the muscles of animal life, which have led to the doctrine of *debility* (§ 410, 476 *c*, 487 *h*, 500 *h*, 569, 639, 743, 746, 780, 915–921, 999 *b*).

961, *c*. In consequence of the foregoing morbid state, the sudden abstraction of two or four ounces of blood, in congestive fevers, uterine phlebitis, &c., will often produce syncope. But, where the complications consist of the ordinary forms of inflammation and venous congestion, a greater loss of blood will be sustained at its first abstraction; though generally less than when the same inflammation is unattended with congestion (§ 137 *d*, 140, 476½ *h*, 803, 804, 806, 973).

961, *d*. In the foregoing cases, a small loss of blood will frequently create a greater tolerance of the remedy; especially if syncope supervene. It happens, therefore, in numerous cases, that we may proceed, soon afterward, to abstract sixteen to forty ounces without producing syncope. The first impression on the organic properties so modifies their condition and lessens their susceptibility, and mitigates the force of disease, and releases the embarrassed circulation, that the subsequent and greater loss of blood often fails of producing any powerful influence, unless carried to a pretty large extent. Dr. Burnett, in describing the congestive fevers of the Mediterranean, says, "it will often happen, after a few ounces of blood have flowed, that syncope will be induced. But, in the course of an hour, the bleeding may generally be repeated, and thirty or forty ounces may be taken away without producing syncope."

961, *e*. In cases of the foregoing nature, there is more or less determination of blood from the circumference, and its consequent accumulation about the right cavities of the heart, by which this organ is embarrassed in its action, and thus contributes to the early syncope. Among the results of the vital change effected in the capillary vessels by a small loss of blood is their immediate expansion, and a returning equilibrium of the circulation. It is true that loss of blood, by increasing the contraction of the capillary vessels, increases, also, the determination of blood upon the heart; and it is in part, as I have said, for this reason, that a small loss of blood often overpowers the circulatory organs. But, when syncope passes away, this state of the circulation, and other morbid phenomena, will have been more or less subdued. The influence of loss of blood which results, as a primary effect, in increasing, or producing a contraction of the capillary blood-vessels, is so essentially different from that of the morbific cause which determines, apparently, the same phenomenon in the cold stage of fever, as in the analogous conditions of venous congestion, that it alters the morbid state, and thus places the vessels in a way to undergo an active expansion; or reaction, as it is called. And herein we witness a critical instance of the alterative nature of loss of blood, and how its influences are exerted, and how, apparently the same phenomenon is not the same, and may be, therefore, due to even opposite causes (§ 150–152, 650).

961, *f*. We sometimes observe a similar prostration of the circulatory organs from acute inflammation, when attended with pain, especially of the intestines. Here, too, is the same inability at first to bear the loss of blood, and the same tolerance created by its abstraction (§ 961, *a*). Thus, Dr. Wardrop : "A gentleman was seized with acute pains in his bowels, accompanied with a good deal of tenderness on slight pressure, along with some degree of febrile excitement. On opening a vein in his arm, only a few ounces of blood were removed, when the pulse sank and he fainted. In two hours afterward I bled him again, and he did not fall into a state of syncope until he had lost about thirty ounces of blood."

Many examples of the foregoing nature occur in the "*Commentaries.*"

962. When syncope is produced by a small loss of blood, and by the loss alone (§ 938), and where this remedy is demanded, the disease is serious, and will probably require one or more prompt repetitions of general bloodletting. Nothing short of this treatment will be likely to subdue the obstinate venous congestions which are the usual cause of the prostration of the system, and of the intensity of the febrile force, if complicated with this constitutional form of disease.

963. If moral causes, or intestinal irritation, have contributed to early syncope, we may generally proceed to the farther abstraction of blood soon after the patient revives, which, in the cases now under consideration, is commonly important (§ 937). If loss of blood, alone, have been the cause of the early paroxysm, a longer interval (four, six, or eight hours) may be most expedient, or necessary (§ 794, 795, 801).

964, *a*. In the cases now supposed, the prostration is sometimes so great, that it may be necessary to create a tolerance of loss of blood by previous stimulation, or before resorting to the repetition of bloodletting (§ 961, *b*). And here, too, enlightened experience abounds in the records of medicine. Thus:

"Immediately upon the application of warmth to the surface," says Dr. Gallup, "take a little blood; perhaps two, four, six, or eight ounces, according as the patient may bear it. If he be a little faint, it is nothing but what is common; a little time will remove it. He will soon bear a second bleeding in this condition better than the first."

Aretæus not only describes this condition of disease, but advises the same enlightened practice, especially if the congestion be the occasion of great prostration and "syncope." "Venas itaque in cubito protinus cædito, multumque sanguinis, sed non semel totum mittito; imo, et bis, et ter, alio die, *quo interim* vires *instaurentur* repitito." Alexander of Tralles discourses in the same manner upon this subject. The language of A. Paré is remarkably graphic in describing the treatment of the Plague and "Pestilent Diseases." It corresponds with the best philosophy of our own day.

"So soon," he says, "as the heart is strengthened and corroborated with cordials and antidotes, we must come to phlebotomy and purging." "You may perceive that the patient is ready to swoon when that his forehead waxeth moist with a small sweat suddenly arising, by the aching or pain at the stomach, with an appetite to vomit, and desire to go to stool, gaping, blackness of the lips, and sudden alteration of the face into paleness, and, lastly, most certainly by a small and slow

pulse: and then you must lay your finger on the vein, and stop it until the patient come to himself again, either by nature, or else restored by art; that is to say, by giving him wine, or any such like thing: then, if you have not taken blood enough, you must let it go again, and bleed so much as the greatness of the disease or the strength of the patient will require or permit" (§ 892½, *i*).

964, *b*. No injury can grow out of the use of stimulants in these cases, while the powers and actions of life are so morbidly affected as to be still more injured by the loss of a small quantity of blood. In these cases, bloodletting, without previous stimulation, impairs still farther the vires vitæ, which are now too morbid to react under its influence, and it increases, permanently, the determination of blood from the circumference to the centre.

964, *c*. In other cases like the foregoing, disease is so intense at its invasion, and Nature so little recuperative, that it may be impossible to create a tolerance of loss of blood. No reaction appears in these cases, and all such patients must perish (§ 149, 150, 794, 795, 801, 808 *b*).

964, *d*. At other times, even in the active forms of inflammation, the power of the system to bear the loss of blood may be destroyed by other remedies. Thus, it frequently happens in croup, that emetics, especially of tartarized antimony, render bloodletting impracticable, particularly when they produce catharsis instead of vomiting; and the patients may then die from their inability to sustain the necessary loss of blood. Thence appears the importance of carefully considering their relative order in the administration of remedies, especially where loss of blood may be essential. I am certain, from observation, that bloodletting has lost its reputation, with some, in pneumonia, &c., from its having been applied unsuccessfully under the prostrating influence of tartarized antimony, and when, in consequence, the powers of the system would only admit of a moderate loss of blood.

965, *a*. Dr. M. Hall, and some other writers, suppose that the power of the system to bear an increased loss of blood is owing to an increase of disease; which appears to me an important practical error. On the contrary, the first bloodletting generally diminishes the activity of inflammation, however it may subsequently acquire its original or greater force. It is true that an increase of inflammation will act in the manner supposed; but it does not thence follow that there has been an increase of disease in other cases because the patient bears a second better than the first bloodletting. Indeed, in the cases now before us, an increase of the venous congestion after the first bloodletting often diminishes the tolerance of loss of blood, on account of the peculiar influences of that form of disease. This, too, is especially apt to occur where the abstraction of blood has been inadequate to the exigencies of the case; and these cases, in consequence, have brought great disrepute upon the remedy, though it be the only practice that supplies a chance of relief.

965, *b*. When too little blood has been abstracted for the exigencies of the disease, although frequently repeated, it may increase the force of the malady. Inadequate depletion so modifies the organic powers, that it rouses them into greater energy; the whole circulation becomes released from its embarrassment in the capillary system;

and the heart being thus, and in other ways, set at liberty and invigorated in force, propels the blood with increasing violence. This mechanical influence, in itself, lights up the flame of disease, and kindles it in other parts already disposed to join in the disordered movements. But much is also due to an augmented irritability of the instruments of action; when irritability would probably have been lessened by a greater loss of blood. The effect produced by the smaller loss, in rousing and otherwise modifying the general capillary action, reflects an exciting sympathetic influence upon the immediate instruments of the local malady, which, in its turn, had equally sustained, in the more direct manner, an exalted state of action; and thus are instituted circles of reacting sympathy between the general and local capillary vessels (§ 982–1003). The same results, it is true, with the exception of the morbific, attend the loss of blood when carried to the extent of its curative influences (§ 961 *d*, 966, 994 *b*, 1005 *e*). The remedy, therefore, in all grave visceral congestions, as well as in inflammations, should reach the point of absolute depression. The powers of life are then not only subdued in energy, but the strength of the impression places them in the way of the recuperative process (§ 961, *e*).

966. Leeching is absolutely inadmissible in the foregoing forms of disease. It is now a great object to relieve the heart of its morbid sympathies with the capillary system, and of the accumulated blood, and thus establish something like an equilibrium in the organs of circulation. But, since it is the primary effect of loss of blood to produce a contraction of the capillary vessels, and to thus determine an unusual volume of blood upon the centre of circulation, that mode of bloodletting should obtain which is least obnoxious to these objections (§ 921). This is general bloodletting; and although it increase the general contraction of the small vessels, its impression is then so rapid, that it more or less subverts, with a corresponding instantaneousness, their morbid state. An immediate dilatation of the vessels is the consequence, the blood circulates with greater freedom, and thus the heart is enabled to throw off the accumulated blood; while the favorable change induced in the extreme vessels moderates or removes their depressing sympathetic influence, by which the heart is farther roused into increased action (§ 921, 934, 965 *b*).

967. The prostration of which I have spoken in this division of my subject is commonly mistaken for debility (§ 469, 476 *c*, 487 *h*, 488½, 500 *h*, 569). Stimulants are therefore too apt to usurp the place of bloodletting, and other analogous means, and to occasion a frightful mortality. On the contrary, there should be no delay of that decisive use of the *remedium principale* which may be demanded by the exigencies of the case. Seize the first moment that nature is ready, should any preliminary steps be required (§ 964, *a*), or she will soon advance to a more forbidding state, and baffle the well-directed efforts of art (§ 863, *d*).

968. Since, therefore, it is always important to do as much as may be requisite, and as nature may admit, at the early stages of disease requiring the loss of blood, we must not be deterred by early syncope from early attempts to abstract the quantity of blood which the exigencies of the case may seem to demand. It is astonishing how soon, in congestive fevers, the morbid powers of life will rally under the

loss of a few ounces of blood, and how soon we may subsequently proceed to a more decisive use of the remedy.

969, *a.* Where venous congestion is associated with idiopathic fever, and the stage of reaction appertaining to the constitutional disease has come on, the prostrating influence of loss of blood is vastly lessened, and far greater quantities are often borne at its first abstraction; and this especially, as will appear in the next following division of our subject, if some active form of inflammation be also attendant; though even now it oftener happens that a second bloodletting is better sustained than the first. In all these cases, the several forms of disease constantly propagate modifying influences upon each other, and these modifications are as constantly varying, either spontaneously, or through the operation of foreign causes.

969, *b.* It will appear, also, that simple venous congestion of the brain sometimes manifests a strong exciting influence upon the organs of circulation; when bloodletting is borne, at its first application, to an extent which never obtains under the usual depressing influence of the disease (§ 688 *c–f, k*, 806, 978).

969, *c.* Although it be generally true that it is the tendency of venous inflammation, whether in its active form, as in phlebitis, or in its sub-active, as in venous congestion, to depress the general circulation, and, when the latter is attendant on idiopathic fever, to delay the stage of reaction, and that it is the usual effect of loss of blood to increase that depression, progressively, till syncope comes on, there are, nevertheless, numerous instances in which the remedy manifests an opposite effect. That is to say, relief may be so instantaneous, that the pulse will increase in volume and force, the dark and trickling blood spout out with a florid hue, after a few ounces have escaped, and while still flowing from the arm. In these cases, the abstraction of blood should be continued till the pulse is again subdued, or the necessary impression will not be produced (§ 806).

969, *d.* So variable in intensity are the morbid changes in the different varieties of congestive fever, especially the local congestions, as in the plague, yellow fever, typhus, &c., at different times, that an impression exists with many, that those diseases must be treated at one time with stimulants, while bloodletting may be necessary at another. But this is neither true nor philosophical. On the contrary, since the same disease is always essentially the same (or there is an end to all medical philosophy, § 752, &c.); or, rather, since disease is most intense and malignant where bloodletting is, at first, most imperfectly borne, if this agent be important in the mild forms, it is more so where the prostration, and, therefore, the amount of disease, is greatest. This, too, is universally sustained by all the best experience (§ 1005).

970, *a.* Cases not unfrequently occur which present many of the phenomena of the prostrated conditions of venous congestion, and congestive fever, which have no affinity with those diseases, but which are constantly confounded with them. Such is the case with injuries from falls, the shock of surgical operations, &c. Here the powers of life are actually and simply reduced; certainly not modified as by the action of specific morbific causes (§ 790 *b*, 961 *b*).

970, *b.* In the latter instances, the abstraction of blood has been often fatal, and should never be practiced unless some inflammation

subsequently spring up. On the contrary, if the depression of life be great, even though the brain have sustained concussion, stimulants should be administered. This should also be the practice in the analogous conditions which are produced by drinking cold water when in an excited state from the united effect of hard labor and hot weather. Opiates should be also employed to relieve the stomach. In apoplexies, when the pulse is sunken, bloodletting should be delayed, or cautiously practiced at first. The morbid state of the brain, or pressure on the organ, has determined, in such cases, a perniciously depressing influence on all the powers of life, and the impression from loss of blood superadded to this morbid influence may destroy the patient at once. Bloodletting will be ultimately necessary, and perhaps to a large extent. It commonly happens, however, that an opposite or exciting nervous influence is determined upon the heart and capillary vessels, at the invasion of apoplexy; that the pulse is full and bounding, the face flushed, &c. In these cases, decisive bloodletting, cathartics, &c., are the principal remedies.—(*Med. and Phys. Comm.*, vol. i., p. 342–361; vol. ii., p. 234–238.)

970, *c.* There are many sympathetic affections supervening on congestive disease of the abdominal organs which appear to most observers to be the leading condition of disease; such as diffuse inflammation of the mucous tissue of the fauces, erysipelas, painful affections of the head, &c. These, however, as I have before said, should be considered rather in the light of symptoms, while the demonstrations of cure should be made upon the primary and principal seat of disease (§ 689, *l*). In the cases supposed, many different tissues may be affected, and there may be, also, much variety in the morbid states. There is inflammation, more or less active, of the venous tissue of the liver, &c., more active inflammation of the fauces, or of the skin. But, the mucous tissue of the stomach, and intestines, is also more or less severely affected, and the head suffers sympathetically. These last conditions, however, are not inflammatory, perhaps; but so nearly approximate that pathological state that they are readily converted into it by any increasing force of hepatic congestion (§ 803), by the undue irritation of cathartics, or by improper food, stimulants, &c. (§ 527 *d*, 528, 529). All other parts suffer, also, more or less, in their vital states; and, although variously, there is yet determined throughout, by the leading conditions of disease, a general coincidence between the morbid states that may be strongly pronounced and those which are less so, and where predisposition is only taking place (§ 143 *c*, 150–152, 870 *aa*). This may be more distinctly appreciated by referring to what I have said of the influences of remote causes (§ 644, &c.).

I am now brought to the application of the foregoing remarks. We see, therefore, from the analogy which prevails throughout the morbid states, how a single remedy, like loss of blood, will strike a blow at any one of the pathological conditions; and the more profound its influence upon the principal, the more completely will it subvert the minor affections. But loss of blood is far from being always necessary in these complex conditions; and we may then find that some internal remedy, as, for example, a compound of six or eight grains of the submuriate of mercury, twelve or twenty of jalap, and one to five of ipecacuanha, will stretch its way to every part of

the organism, touch every part with a corresponding salutary influence, and start every part at once on the way of recuperation (§ 514).

The foregoing example is also a good illustration of an important doctrine which I have propounded to explain what humoralism had neglected; the exemption of all parts of the body from any deleterious action of the blood in those local forms of disease which are capable of modifying its character. The blood is always affected in nearly one universal way in any given condition of disease; whatever the sympathetic complexities. The whole condition of the solids, from the highest to the lowest grade of disease, moves on under reciprocal harmonizing influences of all parts upon each other, though the greater malady exert a controlling power. The morbid blood, therefore, is exactly adapted in its condition to all parts, and, therefore, molests none (§ 137 *e*, 143 *c*, 847, 870 *aa*, 984).

Of Bloodletting in the recognized Forms of Inflammation.

971. Although I have demonstrated in my Essay on Venous Congestion, contained in the *Medical and Physiological Commentaries*, that its pathological state is constituted by inflammation of the venous tissue, the subject, notwithstanding its importance, has received as yet but little attention from the hands of others; but stimulants, as usual, especially in Great Britain and France, continue to be the favorite means of treatment; though not so, nor ever so, in these United States. The decision of the right still rests with futurity; but that future, in the prospective view of America, in the rise of the North of Europe, and the retrospective view of Southern Europe, cannot be distant.

972. I now approach, however, conditions of disease which have been, from immemorial time, of an admitted inflammatory nature; however various the hypotheses as to their pathological cause. We now lose sight, or mostly so, of that depressing influence of venous congestion, which so often gives malignancy to fever, and embarrasses or disarms the hand of art, and are in the midst of innumerable modifications of the same pathological state as presented by other tissues, that reflect upon the system a series of different influences, though often of an intensely morbific nature (§ 935, *d*).

973, *a*. To comprehend fully the effects of loss of blood in the inflammatory conditions now before us, it is still important to bear in mind the reciprocal sympathies among the capillary vessels of all parts and with the heart, as set forth in the preceding divisions of our subject, since upon them depend, as in simple forms of venous congestion and active phlebitis, the constitutional or sympathetic effects of all local inflammations. But these constitutional results, although dependent upon the same processes of sympathy as those which spring from venous congestion and active phlebitis, present an aspect more or less different. The local conditions exalt, instead of depressing, the general action of the circulatory organs. There is an expanded, instead of a contracted state, of the general capillary system; the circulation is free, the heart unincumbered with accumulated blood, and beats with more than its natural vigor and frequency. These inflammations, therefore, commonly act upon the system at large after the manner of direct stimulants, and thus tend to counteract the depressing effect of loss of blood (§ 226, 229).

973, *b*. The point, therefore, to be now observed is an apparently oposite effect of sympathy as exerted by local inflammations upon the organs of circulation from that which attends the loss of blood or any other sedative agent. One is exciting, the other depressing. One excites general arterial action, the other subdues it.

974, *a*. Certain parts, under equal degrees of common inflammation, maintain the general exciting influence upon the organs of circulation against the depressing effects of bloodletting more than others, and this is especially true of the brain (§ 230). In many forms, also, of specific inflammation, as in acute rheumatism, the local vessels are in a peculiarly irritable state, and produce an excessive exciting influence upon the whole sanguiferous system; the heart itself often participating, by sympathy, in the rheumatic inflammation (§ 525, 526 *b*, 527). Something in this respect is also due to the nature of the tissue which may be the seat of the affection; articular rheumatism, for example, deriving an obstinate character from the peculiar vital constitution of the ligaments (§ 133, 134). Here the affection may yield only to great losses of blood; especially if the chief dependence be placed upon this remedy. Owing to the same pertinacity of local disease, and its general influences, cathartics make less impression than in most other active inflammations, unless of the brain. For the same reasons, also, gradually-increased doses of the antimonials are commonly borne to a large extent, and vascular action yields slowly to their influence. A common principle is concerned with all the remedies.

974, *b*. On the other hand, when inflammation, in rare instances, is aggravated or induced by an excessive loss of blood, such is the combined nature of the exciting cause and its curative effects, that the modified irritability of the vessels may readily yield, at the moment, to a farther loss; but if general bloodletting be now practiced, it will soon go on with its deleterious influence (§ 950).

974, *c*. Inflammation of the brain develops very powerfully and obstinately an exciting nervous influence, which not only holds in subjection, against the usual influence of loss of blood, the whole capillary system and the heart, but this nervous power is determined upon the vascular system of the brain itself with greater intensity than upon the instruments of inflammation in any other part (§ 227, no. 1, 230). Hence it is, that general bloodletting is commonly necessary to a greater extent in inflammations of the brain than of other organs. This is the reason, also, why general bloodletting is required by the cerebral inflammations and congestions of infants, when leeching will often succeed in inflammations of equal intensity in other parts at that period of life (§ 576 *e*, 925 *b*, *c*, 951 *b*, *d*, 955, 992).

975, *a*. Again, another general law. So great is the sympathy between vessels of the same order, and especially those in which the organic properties are most active, that while those which are engaged in the process of inflammation refuse to contract, the whole series throughout the body are thus, also, maintained in a state of excitement. This is peculiarly true when the brain is the seat of inflammation; for, while the contraction of its capillaries tends, as a sedative, to prostrate the general circulation, their refusal to contract, on the other hand, not only contributes to sustain the general circulation, but the influence of a stimulant is, by this cause, still exerted upon the organ,

and still propagated to the heart and arteries (§ 226, 229, 230, 480–483, 500, 526 *a*, 916–921, 929–936). The contraction of the vessels of the brain is partly prevented by their peculiar relation to the organ which is the principal centre of the nervous power, and in part by the tendency of that condition to prevent a contraction of the corresponding vessels in other parts. This peculiarity depends upon a special nervous influence which is exerted upon the vessels of the brain in a state of inflammation (§ 231), and is thus distinguished from that condition of the vessels in other parts when the seat of inflammation. In inflammations of other organs, therefore, the influence of the law by which excited vessels hold in partial subjection the corresponding series throughout the body is less, and is sooner overcome by loss of blood, and general prostration follows sooner, than when the brain is the seat of inflammation (§ 140).

975, *b*. Hence the reason why greater loss of blood is generally necessary in cerebral inflammations to produce syncope, than in similar affections of other parts. In the latter cases, and where general bloodletting is used, the capillaries of the brain contract at the moment, at least, that contraction begins in the instruments of disease; and the depressing nervous influence then becomes a powerful co-operating cause of the general contraction (§ 930–934, 940–942). But, it is now obvious, that when the brain is the seat of inflammation, this influence is obtained with greater difficulty. Before it can be established by loss of blood, the contraction of its highly-excited capillaries must be effected, and that opposite state of nervous influence which arises from their excitement must be first overcome (§ 230). This influence may be often obtained most perfectly, and propagated most extensively, by long-continued syncope. This will sometimes happen in most inflammations of other parts, and sometimes of the brain itself, by the loss of small quantities of blood (§ 951 *b*, 955 *b*).

975, *c*. We learn from the foregoing philosophy the reason why, in cerebral inflammations, there is oftener a rise of inflammation after syncope from loss of blood, than in inflammations of other parts. But, in all the cases, if a repetition of the remedy be required, the same influences will, in a general sense, operate again, and again enable us to abstract all the blood that may be salutary at the next operation; and so on, till a permanently salutary change is established.

976, *a*. Again, in certain diseases where the cerebral and ganglionic systems appear to be much involved, but in an unknown manner, and where, perhaps, there are no special marks of inflammation in any part of the body, vast quantities of blood may be lost without inducing syncope. In these cases there is great nervous irritability. I have seen upward of thirty ounces of blood taken from the arm of a man, in hydrophobia, after the radial artery had ceased to be felt; the patient being all the while in an erect posture, and remaining to the last without any sense of faintness. Similar cases are recorded by the East India surgeons.

976, *b*. On the other hand, we have an opposite state of the cerebral influence, in some cases of mania, and the delirium of drunkenness, where, from its depressing effect, the condition of the system has been erroneously compared to that of debility (§ 569, *d*). In these particular cases, bloodletting is imperfectly borne; evidently from its strong impression upon the nervous centres. In the case of drunk-

enness, there is venous congestion of the brain, and so modified by the remote causes, as to often lead to early syncope (§ 816 *b*, 978).

976, *c*. Analogous modifications will also arise from any peculiar manner in which the organic properties of other parts may happen to be affected; not only in specific inflammations, but from those shades of difference which attend common inflammation (§ 652 *c*, 722). Particular influences will be determined upon the whole system by these modifications, according to the nature of the combined influences transmitted to the nervous centres, by the exact modification of disease and the special influences it may exert on other parts, and give a corresponding direction to loss of blood (§ 150, 151, 228, 500, 514 *h*). Thence it will appear that much will depend upon the natural relation of other organs to the nervous centres, and to other parts of the body, and the special vital constitution of each (§ 133–138, 143–152).

Other, and more accidental causes, may contribute to these results. They have all an important bearing upon the effects of loss of blood, often playing an important part in the phenomena of bloodletting; leading to syncope from the loss of an ounce of blood, where we may have calculated upon a pound or more, or where yet more may be demanded by the exigencies of the case. The effect, therefore, of loss of blood may throw, at once, a flood of light upon some obscure condition of disease, as some ill-defined venous congestion, or upon some natural peculiarities of constitution, &c. Or, again, it may be useless, or hazardous, to bleed a patient far advanced in typhoid pneumonia, or in the pleurisy of confirmed phthisis, or in less serious inflammations incident to the scrofulous diathesis, or in the phlegmatic temperament.

It is therefore manifest, that peculiar impressions will be determined upon the nervous centres by the loss of blood, and thence propagated with varying effects upon other parts, according to the natural constitution of each individual, the nature, extent, force, duration, and organic lesions of disease, the organs affected, especially if the brain be its seat or otherwise participate, and according to the nature and extent of the cerebral derangement, and the morbid sympathies which may be exerted by this and by other parts (150, 151, 892$\frac{4}{5}$ *i*, 1008).

977. But it cannot be too strongly urged, that in abstracting blood, and in the administration of cathartics, emetics, antimonial alteratives, &c., it should be considered that it is the constant tendency of an inflamed part to prevent a contraction of the capillaries of other parts, and thus, also, to maintain the action of the general circulatory system (§ 933, 936). We shall not obtain a proper amount of this general contraction, so important to the case, until the loss of blood is sensibly felt by the part inflamed; and this may depend upon a great variety of circumstances, even upon the contingency of a large or small stream of blood, the posture of the subject, the state of his mind, &c. But, in all severe inflammations, the general impression should be fully produced, and this is only effected at, or near the point of syncope; the patient being always in a sitting or elevated posture.

978. Although, as we have seen, it is the tendency of venous congestion to depress the powers of circulation, there are many chronic cases of this disease, in which the law relative to inflammation of other tissues is found to obtain, though in an inferior degree. The pulse is more or less excited and hard, and loss of blood is more or less borne, at the beginning of the treatment, as in the other cases. This

is especially true not only of chronic, but of the more rapid form of the disease, when affecting the brain. The chronic conditions, however, sometimes become suddenly aggravated, and the general circulation sinks down suddenly under this aggravated state, when syncope may follow a small abstraction of blood (§ 688 *c–k*, 786, &c., 976 *b*).

979. From the foregoing considerations it appears that general bloodletting is the great remedy for all inflammatory affections of important organs, with those exceptions of a chronic nature to which leeching is more appropriate, and which occur in that division of our subject for the purpose of illustrating its philosophy (§ 914, &c.). There should be no hesitation, in the active forms of this disease, with the most cautious practitioner, in meting out a full measure of the capital remedy. The tendency of the affection to sustain the system under the loss of blood, and the phenomena of increased excitement, should nerve the weakest arm to an obvious, easy, and important duty. This duty, however, it is my purpose to enforce yet farther, when I shall have reached the experience, and the details of practice, that remain as the choicest legacies of the illustrious dead.

980. The foregoing remarks upon the tendency of inflammation to sustain the system under the loss of blood, and the rapidity with which small losses, in venous congestion, will place the organic properties in a state to bear a measure which would prostrate the organs of circulation in health, are farther illustrative of the great law of adaptation, by which nature has contrived all things in organic life for its ever-varying exigencies (§ 143 *c*, 733 *d*, 847 *g*, 870 *aa*).

Of Bloodletting in Simple Continued, and Simple Intermittent Fever.

981. Where fever is not complicated with local congestions and inflammations, loss of blood is not often required, unless to reduce the force of arterial excitement when so considerable as to endanger the appearance of those local affections. If this condition, or any condition of the febrile action, do not soon abate under the influence of cathartics, an emetic, and appropriate alteratives, recourse should then be had to general bloodletting; though it will not be often necessary to carry the remedy beyond a moderate extent. If the treatment, however, be early and judiciously begun, the disease will commonly surrender, in its early stage, without the co-operation of the principal remedy for those conditions of fever which are associated with inflammation and venous congestion.

In the cases of high arterial excitement to which I have now referred, it is important to consider that three principal causes are in operation which may lead to the development of inflammations. The most important is the morbid and highly irritable state of the capillary and extreme blood-vessels. The second is the force of the circulation, which contributes, as a mechanical cause acting upon the morbidly susceptible vessels. The third is the augmented volume of blood in those vessels, and whose influence is chiefly that of a vital stimulus (§ 137 *d*, 710 *b*, 784).

982. But, it often happens, as when fever and venous congestion appear in connection, that inflammation presents itself simultaneously with the constitutional malady, or the latter may be preceded by either local form of disease, or these local states may spring up in the progress of the general malady (§ 779, 813). In the last two in-

stances, the affection which is first in order contributes more or less as an exciting cause of the supervening affection (§ 714, 715, 779). If the general affection then continue to advance, congestions or inflammations of other parts are liable to spring up in quick succession; the general affection, and the local developments, and the predisposition of organs to inflammation or congestion, being the principal causes of the successive explosions of disease, and mutually aggravating each other (§ 137 *d*, 714, 715).

983. From what has been now said, and of the treatment of inflammation and venous congestion, we may make up our minds that there can be no tampering with the complicated forms of fever, whether associated with one or the other of the local conditions of disease. In either case, especially in continued fever, general bloodletting is more imperatively demanded than by either of the local conditions in their independent state; and the earlier this important step is taken the better. Nor should we strike with a sparing hand, nor move at a tardy pace; but rather let the first be a heavy blow, and as oft repeated as the foe may rise, yet always proportioned to its own degree of strength. Let those, however, who may not relish this "rash advice," gather wisdom and moral courage from the experience and philosophy that yet await us from abler hands.

984, *a*. Nevertheless, in the complications of intermittent fever with venous congestion, and sometimes with inflammation, such is the nature of the predisposing cause, and the local affections are so apt to be imbued with its influence, that it frequently happens that bloodletting may fail of the requisite impression upon the local forms of disease, and the special aid of the Peruvian febrifuge, or analogous means, may be useful, or necessary, in subduing the local affections after a due impression has been made by loss of blood, cathartics, &c. (§ 1003).

984, *b*. The foregoing reference to the remote causes of disease with a view to some special deviation from the general principles of treatment is exactly on a par with the antidotal treatment of poisons. The quinia, which may be ultimately necessary to overcome intermittent fever, or its associated inflammations and venous congestions, is parallel, in principle, with the ammonia which is administered in cases of poisoning by hydrocyanic acid, and with other analogous examples. It is true that, in the latter cases, the counter-agent acts in a purely chemical manner, while in the former the special agent operates through vital influences alone. I have thus adverted to this analogy, in deference to the humoral pathology, and especially on account of a vague belief that quinia cures intermittents by neutralizing the miasmatic poison.

Now the whole of this philosophy will be set right by considering the modus operandi of the best antidotes for poisonous doses of opium; namely, coffee and the cold dash. Here there is no difference, in their acceptation as poisons, between the opium and the miasma. Both have equally established their morbific effects.

And now as to the "antidotes for opium." Who ever imagined that coffee removes the morbid states by entering the circulation, and there neutralizing the opium? But, I may be mistaken; and therefore will rest my conclusion upon the restorative effects of the cold dash (§ 828 *d*, 905 *a*). I need not add that the modus operandi of

quinia, in the cure of intermittents, is exactly equivalent to coffee and the cold dash in that of poisoning by opium (§ 137 *e*, 150–152, 662 *a*, *b*, 892 *b*, *c*, 904 *c*, *d*).

In all such cases, therefore, the special treatment may be considered antidotal; since, as in the cases where we merely attempt to neutralize a poison while it yet exists in the stomach, we equally apply the treatment in the former case to certain specific effects which have resulted from causes which are alike distinguished by very special virtues. In one case we attack the cause itself; in the other, the effects which it may produce.

It is therefore sufficiently evident that in the administration of quinia in the treatment of intermittent fever, and in other analogous examples, we leave, more or less, the general principles which apply to the generic character of the diseases, and turn some agent of special virtues against the modifying influences of such predisposing causes as are capable of bending the general pathology from its more common form. But, it is rare that the general plan of treatment is not more or less in demand; or that the special remedy will come under the law of universal adaptation till the whole system is submitted to influences by such remedies as are consistent with all the varied coexisting pathological conditions (§ 847 *g*, 870 *aa*).

Some other examples of practical importance will, at the same time, advance our philosophy upon the subject under investigation. Thus, bloodletting may, or may not be necessary in a scrofulous inflammation. If it attack the lungs, it will be important; especially in its early and active stages. Here the remedy is of universal adaptation. If the superficial lymphatic glands be the seat of the affection, leeches may be proper. But, in such cases, we are apt to leave the general principles of treatment, and to refer specifically to the nature of the predisposing cause, which is here implanted in the constitution of the individual (§ 561, 586, 659, 661, 666). Experience has shown that iodine, which does not belong to the remedies for common inflammation, is especially adapted to certain states of scrofulous inflammation. But, it is only to subdued forms of the disease that it is suited; while loss of blood is universally applicable in all the active grades of the disease, whatever be the part invaded, and may place every part, and the whole system, in a condition for the salutary effects of iodine (§ 137 *e*, 143 *c*, 150, 151, 163, 870 *aa*).

Again, if the inflammation be syphilitic, and the constitution be invaded by its predisposing influences, bloodletting, cathartics, &c., may or may not be necessary. But, a general antiphlogistic plan should be pursued; at least so far as to exclude stimulating food, which may be all that the case will require (§ 856). In a general sense, however, we should have a more direct reference to the nature of the remote cause, and administer mercurial preparations; since experience has shown this to be the safest and most efficient treatment. Here, then, mercury assumes the character of what is called "a specific" (§ 865, 892 *aa*); though it is one of the antiphlogistics which fall within the principle of general adaptation to inflammatory diseases.

984, *c*. When speaking of expectorants, and at other times, I have stated the importance of deriving our indications of cure from what we may witness of the results attendant on the recuperative efforts of

nature (§ 862, 863, 892$\frac{4}{5}$ *i*). I am now led to recur to the subject on account of the great abuse of the principle in the treatment of acute inflammatory affections of the lungs by stimulating expectorants; which are administered for the reason alone that expectoration is one of the consequences of the natural process of cure. On looking a little farther, however, we find that bloody mucus, and pure blood, are often expectorated in pneumonia, and in incipient phthisis; and that hemorrhages are frequently occurring, as the consequence of congestion or inflammation, from all parts of the body. Here, then, is a remedy for inflammations of all parts, suggested by Nature; while expectoration refers to one part only. What is thus inculcated as to the practical application of the more comprehensive principle is enforced by all the most enlightened experience (§ 863, *f*).

985. Finally, when bloodletting is judiciously practiced, it often supersedes the use of a long train of other remedial agents which may ultimately bring relief, or lessens their number and dose, substitutes the milder for the more energetic, prepares the way for their quick and salutary effects, and saves to the patient much suffering, and secures a speedy convalescence.

Of Bloodletting in the Cold Stage of Fever.

986, *a*. Bloodletting has been practiced successfully by many physicians in the cold stage of intermittent fever. It is not, however, with any reference to this consideration that I have given to the subject the distinction of a chapter by itself; but for the greater purpose of illustrating still farther the influences which are exerted by the loss of blood.

986, *b*. That the disease should be thus suddenly arrested is entirely conformable to what I have said of the modus operandi of bloodletting, and goes to confirm the philosophy. The capillaries being then in a state of universal contraction from disease, if loss of blood have its special influences upon the organic properties of these vessels, it should be the effect of such a cause, in suddenly, greatly, and universally increasing that contraction, through other and very different influences, so to modify the morbid state as to interrupt the succession of the hot stage. But the abstraction of blood must be carried to the point of syncope, that it may thus determine a powerful nervous influence upon the instruments of the morbid process; or that change will not be established which is necessary to prevent the stage of reaction. In these cases, however, the necessary quantity of blood is commonly small; and syncope, therefore, is easily induced. But, as the morbid contraction depends upon a different cause, and as the vital properties are differently affected from what bloodletting produces, although the remedy occasion the same phenomenon, it often happens that no inconsiderable loss of blood will be sustained before that change can be established in the small vessels which is necessary to perfect the contraction which is incident to bloodletting, and which is the precursor of syncope.

987. How, therefore, shall we interpret by any other philosophy than that which I have propounded the sudden interruption of fever in its cold stage by the loss of a small quantity of blood, when no amount, perhaps, would have arrested the disease if taken at any other period? The quantities, also, necessary to success depend, in part,

upon the precise period of the cold stage; whether at its beginning, or near its termination in the hot stage. Less is necessary, *cæteris paribus*, in the former than in the latter instance; although nature, in the latter case, is preparing for a recuperative effort (§ 675). And so the result will be influenced by the application of the remedy during the first paroxysm, or by its delay till a later, and this often in proportion to the delay. It is true, diseases generally yield most readily in their forming stage; but in intermittent fever, the disease may be said to be renewed, in a measure, at each paroxysm. Like other affections, however, it acquires more or less obstinacy from the force of habit, and from the influence of local inflammations and venous congestions which so often spring up in its progress. But that habit is more or less broken during the intermission; when Nature is aiming at restoration (§ 557, &c.).

988, *a*. Here, also, may be shown absolutely the error of all the mechanical hypotheses which have been put forth as to the philosophy of bloodletting, and which have so extensively governed the application, or, rather, have led to the neglect, of the remedy. If we consider the prevailing one, that loss of blood operates by mechanically reducing the volume of the circulating mass, and thus empties the enlarged capillaries in inflammation and in the hot stage of fever, it is at once contradicted by the immediate and salutary effect of the loss in the cold stage of fever, when the same capillaries and the same instruments of disease are already so contracted that the blood has receded from them toward the central part of the circulation; while the immediate effect of the loss of blood is to determine an increased volume upon the capillaries (§ 910, 935).

988, *b*. It is, however, unnecessary to pursue the inquiry; but it is well to advert to the fact that the phenomenon now before us is equally demonstrative of the error of imputing syncope to the reduction of blood within the cavities of the heart; since, in the cold stage of fever, blood is always accumulated about that organ, and as the contraction of the capillaries is farther increased by loss of blood, so, also, is the central determination (§ 935).

For the full understanding of the foregoing subject, the inquiring reader will refer more extensively to what has been said of the agency of the nervous power in determining the effects of loss of blood.

989. The foregoing considerations enable us to understand why bloodletting is more useful just as the subsidence of the hot stage begins, than at its earlier periods. Nature is now consummating her efforts at relief. The capillary vessels are every where about to contract to their natural volume, as a consequence of another modification of their vital state, and differing, therefore, from that of the cold stage, and from that which is induced by loss of blood. The secretions are about to break forth in virtue of this recuperative process, and bloodletting will now accelerate what nature is instituting. At any other stage of reaction this curative effect is less, since nature does not then so co-operate with the remedy as when the hot stage is on its decline. Should syncope, even, be induced during the rise of the hot stage, reaction will be very apt to return, though it pursue a mitigated course. A much smaller loss of blood will also subdue the general circulation when the hot stage is beginning to decline than during its rise, and leave a more permanent impression upon disease. Nevertheless, the

violence of reaction, &c., may be such as to increase or give rise to local inflammations; and where this is apprehended, or for the relief of pain, general bloodletting should be practiced early (§ 675, 863 *d*, 1003).

Of Bloodletting in Apoplexy.

990, *a*. The modus operandi of bloodletting, as well as the adaptation of this remedy to the special circumstances of disease, and its critical influences according to those circumstances, especially in its relative effects through the instrumentality of the nervous power, may be now advantageously considered by contrasting its results in certain states of apoplectic affections with what has been said of the counteracting nature of inflammation, and of the nervous influence, in preceding sections.

990, *b*. It is the well-directed application of bloodletting which constitutes the principal means in the treatment of sanguineous apoplexy; and although it may be often important to delay the abstraction of blood, it will be generally necessary in the progress of the cure. Such, indeed, is the concurring opinion of almost all writers of eminence; although it is a remarkable fact that the practice is not founded upon successful experience, or any agreement in pathological views. Even those who condemn bloodletting in pneumonia, enteritis, or other grave inflammations, are neither intimidated by age, nor by expiring nature, when apoplexy makes its invasion. Some are prompted by a supposed rupture of a vessel, which they expect to stanch by bleeding from another; while a few, more philosophical, regard the effusion as the result of a morbid process analogous to secretion. It is with all, however, a mechanical operation. There is too much blood in the brain, and it must be drawn off by the lancet. That is their *modus operandi*, and that the extent of it. Hence the disastrous results of indiscriminate bloodletting in apoplexy. But, if the philosophy which I have set forth as to the operation of loss of blood be founded in nature, it will readily appear that the sudden and violent lesions of the brain in apoplectic affections offer us cases for great and unusual discrimination as to the time, extent, &c., of the remedy; while, also, they confirm that philosophy, and enforce the importance of an enlightened understanding of the principles through which bloodletting operates. It is said by Clutterbuck, that "there is perhaps no disease, the treatment of which requires to be so much directed by theory or general principles, as apoplexy. The practice in general use is, for the most part, unnecessarily violent; and, in some respects, contradictory. Bloodletting to an unreasonable extent, vomiting, purging, blistering, sinapisms, and a great variety of other stimulants, have all been administered with an almost indiscriminate and unsparing hand; as if, to insure recovery, it were only necessary to have recourse to sufficiently active means, without much regard to their nature or effects."

990, *c*. Besides the importance of a proper reference to the influences of bloodletting in cases of apoplexy, there are often present certain inscrutable conditions of the brain which are liable to embarrass the most enlightened judgment. It is often impossible, for example, to understand the exact pathological condition of the brain, upon which the due regulation of bloodletting will essentially de-

pend. If there be hemiplegia, it is almost certain that extravasation of blood has taken place. This condition, with the rare exception of the rupture of a diseased artery, is indicative of venous congestion of the brain, with which inflammation may coexist (§ 803, 805). We have, therefore, in these numerous instances, a formidable condition of cerebral disease, and a laceration of the cerebral substance. Again, however, there may be only a state of venous congestion, or of serous effusion, or some pathological condition which is not denoted by any visible signs after death. With the exception of paralysis, the phenomena may be exactly the same in all these conditions of the disease at its invasion. In the first two varieties, bloodletting, sooner or later, is probably necessary, in almost every case, to overcome the morbid action; though its early application may induce, or hasten, a fatal result. In the last two, which are known as *serous* and *nervous* apoplexy, the loss of blood is comparatively unimportant, and may be injurious at every stage of the disease (§ 673).

990, *d*. But the treatment of apoplexy has been less the fault of hypotheses than an unmitigated application of bloodletting; neglecting the peculiar relations which the brain sustains to other organs, and the consequent modification of their properties and functions when the brain is suddenly and violently disturbed. So far as this organ is independently concerned, whether the proximate cause of apoplexy consist in pressure from excreted blood, or simple inflammation, or venous congestion, bloodletting is clearly indicated, and, to avert an impending attack, should be applied without much reserve. But when the paroxysm ensues, it is not alone the brain which suffers in a new and peculiar manner. Every vital organ sustains a shock, and each becomes a subject for particular care. Disease is now coextensive with the system, for the powers and functions are universally deranged (§ 226, 227, no. 1, 230, 231, 480–485, 489–492, 508–511, 943, 946).

990, *e*. Hence the importance of ascertaining, as nearly as may be, how extensively the powers of life are disturbed in each individual case, that we may not complete their extinction by precipitate treatment (§ 920, 934, 937, 940, 941, 943, 944, 947–949).

990, *f*. The consequences, which are determined by the sudden lesion of the brain in apoplexy, will depend not only much upon the natural constitution of the individual, often upon the precise nature and seat of the lesion, and the antecedent condition of the organ, but they will be variously modified by the pre-existing state of other parts; whether the system was in a state of health at the time of the seizure, or whether important organs may have been previously diseased, and thus incur a more profound lesion after the attack, and send back upon the brain the shock they have sustained, and again receive the reverberation; and whether, also, such disease may not have developed the cerebral derangement, and remain a powerful aggravating cause (§ 514, *h*, &c.).

990, *g*. The variety of lesion sustained by the properties of life, in apoplexy, is denoted by the symptoms, and the symptoms only. The pulse of an athletic subject may become, as in cases of concussion, almost insensible at the moment of the attack; while that of the feeble may acquire a volume and force exceeding its natural state. The general circulation is roused at one time, and prostrated at another,

The cerebral lesion has now the effect of an excitant upon the system, and again it is a deadly sedative (§ 226, 476, &c.). In one patient, the pulse falls suddenly to forty strokes in a minute, while in another it is as suddenly raised to more than a hundred. In one, it beats with staid regularity; in another, it intermits; in another, it hobbles; and in a fourth, it rises and falls in volume, in coincidence with the prolonged acts of respiration. There is nothing uniform about it.

990, *h*. It need not be said how profoundly the stomach is affected, how variously respiration, how differently the voluntary muscles, the sphincters, &c., suffer (§ 476, &c.).

990, *i*. Considering, therefore, the varied influences of the brain upon the properties of life in apoplectic affections, and the manner in which we have seen that bloodletting affects this organ, and the consequent impressions which are propagated from it over the whole system, it must be obvious, where the general lesion is very profound, that the abstraction of blood at the onset of the attack may so increase the pernicious influence of the brain upon the sinking powers of the system, that neither nature nor art can repair the injury. This will be especially true of such cases if we bleed to syncope (§ 940, 941). But the abstraction of blood is powerfully felt, in a direct manner, by the vital properties of every organ; and where these powers are excessively depressed by the nervous influence, and that influence constantly maintained by the peculiar condition of the brain, it will happen, in the foregoing cases, that there will be no ultimate recoil from the depressing effect inflicted by the loss of blood. Here will be also another shock added to the direct injury from loss of blood, since the violence thus inflicted upon the system at large will be extended, by sympathy, to the brain; while this organ will reflect every pernicious impression it receives from others.

990, *k*. It should be also considered that effusion probably exists within the brain, and that bloodletting cannot reach this part of the exciting cause; that the effect of the effusion, although it be diminished, must continue for an indefinite time, and that if we lessen too much the energies of the system, they will at last fail from its increasing influence. While, therefore, we strive to arrest one evil, there should be an equal care not to increase another.

990, *l*. The importance of bloodletting will depend, also, upon the nature of the fluid effused; of which we may, perhaps, form some conjecture from the antecedent history of the case. In serous apoplexy, the cerebral congestion, or inflammation, is generally, from the beginning, in a low state, and is probably much subdued by the effusion. It may be, therefore, chiefly the immediate object of bloodletting to diminish the impulse of the circulation upon the brain, and, perhaps, to lessen a state of congestion in the abdominal organs that may continue to operate upon the brain. Serous apoplexy, however, is not common. Dr. Cheyne and others consider the ratio of the sanguineous to the serous as 98 to 100.

990, *m*. In the sanguineous apoplexy we have a more or less different state of things, and other objects are presented for consideration, than in the serous form. We have, then, not only to lessen the impulse of blood, and to strike at any remote predisposing congestions, but we must, as speedily as possible, reduce the congested state of the cerebral veins, and thus arrest the progress of the hemorrhage.

and re-establish the natural circulation and healthy functions of the brain.

But the moment when bloodletting may be applied with advantage, and the extent of the remedy, must be directed as much, or more, by the existing state of the general symptoms, as by any pathological condition that may have led to the paroxysm (§ 150, 151, 990 *c*).

990, *n*. It behooves the physician to meet every case of apoplexy with entire self-possession, and to consider that no subject requires the exercise of greater skill, and, perhaps, of firmness. It is often now, as with the surgeon when he is summoned to some embarrassing operation, but in the right performance of which the life of the subject is immediately concerned. The authority of custom, sanctioned by the most acute and renowned observers, will be likely to embarrass our judgment, paralyze our independence, and hold us spell-bound, when all may be depending on the unbiased dictates of the understanding. The difference of an hour in the application of bloodletting may be for the weal or the woe of the patient. Shall we deliberate? Professional reputation may be in peril; but the greater will be the reward to a sensitive and enlightened mind. Where art can be of any advantage, there will be always time for calm investigation of doubtful cases. Such are the recuperative powers of nature, they will generally struggle for a time with success; at least in cases where art can be instrumental. "It is probable," says Heberden, "that far the greatest part of paralytic and apoplectic patients would recover some degree of life and strength by the unassisted efforts of nature." It is this partial recovery which we should await, in certain cases, before resorting to the abstraction of blood. If Nature be too much struck down by the blow for an independent effort, we shall hardly contribute any useful succor by inflicting another. If, also, the powers of life be greatly prostrated, action is, of course, in a languid state. Whatever disease may exist in the brain is, for the present, controlled by the same principle. Hemorrhage is suspended; and the functions, every where, whether natural or morbid, are nearly at a stand. It is here, in the severest cases, in respect to the general condition of life, as it is in concussions of the brain; when, it is said by Mr. Abernethy, "it would appear in the first stage that very little can be done." This has now become the doctrine of surgeons.

990, *o*. When bloodletting is of doubtful expediency in apoplexy, and this is commonly only soon after the seizure, in cases that admit of relief, the abstraction of blood should advance slowly, and its influence be carefully observed (§ 937). The result from a small quantity of blood may be such a relief to the brain, that the pernicious influence of the organ may be so withdrawn from the system that the remedy may be soon repeated, and to a greater extent (§ 961, *d*).

990, *p*. Having brought the system, in bad forms of the disease, out of its alarming prostration, either by moderate stimulation, or cautious bloodletting, or, what is generally better, by intrusting it to its own resources, it will become important to estimate the probable extent of disease in the brain and other organs. And here I cannot but repeat the important fact that sanguineous effusions are generally the result of disease, and that they very rarely depend, even within the cranium, upon any primary rupture of blood-vessels. Dissections prove

that this condition, in almost all cases of sanguineous apoplexy, is attended by venous congestion. This view of the pathology, while it is entirely more inauspicious to the hopes of the patient, than that which regards the effusion as the simple result of a ruptured vessel, requires more energetic means of treatment than the latter. Indeed, were simple rupture the source of the effusion, I see not in what respect art is likely to be instrumental. It cannot be, as is commonly supposed, by diminishing the force of the circulation that we obtain much ascendency over the complaint. Indeed, in many cases, where the pulse is prostrated, relief is effected while the energy of the heart rises under the influence of the lancet. The philosophy of the effects of this remedy relates mainly to its impression upon the organic properties of the capillary vessels.

990, *q*. We may conclude, then, that with all the advantages of the most enlightened pathology, and the most appropriate treatment, the apoplectic must, generally, exist for a long time in a perilous condition. In the early stages, a formidable state of morbid action is to be overcome by energetic measures, whose timely application is more surrounded by difficulties than in any other disease. The brain, too, in the cases supposed, has sustained a fearful laceration, and a concrete effusion of blood is probably compressing and irritating the whole organ; there to remain, quivering like the arrow of death, till it is slowly removed by a system of vessels, which, it is supposed, because unseen, have no existence.

990, *r*. It has not been my object to speak of cases that obviously admit of immediate bloodletting. These are common, and may demand an extensive application of the remedy. But the only rule that can be assigned in regard to the quantity of blood that should be abstracted will probably be found in the foregoing considerations.

990, *s*. In estimating the effects of cerebral disease on the system, we must duly consider the various relations of the brain to other parts. Considered simply as an organ, it is liable to the same modes of disease as other organs, and to the same relative sympathies as exist among other parts. But this is a small part of the important relations of the brain. It is especially destined to preside over the great functions of the body, however they may be the result of powers that exist and act in independence of the brain; and whenever its organic functions become diseased, these specific relations to the system are affected in consequence (§ 455, 456). This complex derangement, in apoplectic affections, will produce the most varied results; and, according to the influences of the brain upon other parts, and their reaction upon the brain, will be the endless variety of phenomena.

990½, *a*. In conclusion of the foregoing subject I may finally say, that, from what has been there presented relative to the nervous power, and from the extensive researches of a more critical nature in preceding sections, it appears that the nervous power is peculiar to animals; that it is a vital stimulus, *sui generis;* that its great final cause is to subserve the function of sympathy, and to thus maintain all parts of the organism of animals in harmonious action; that its only participation in the function of motion is that of acting upon the organic property, mobility, through its primary operation upon irritability; that it is extremely susceptible of influences from the operation of external and internal causes, moral, vital, and physical; that these in-

fluences result in preternatural developments and various modifications of the nervous power, under the influence of its own nature, but corresponding, also, with the nature of the remote causes, respectively; that it is then determined in a preternatural manner upon remote parts, according to their existing susceptibilities, and according, also, to the nature of the causes by which it is developed or modified, whether by the will, moral emotions, or by organic or physical causes, and that the motor channels which are elected for its remote effects are, apparently, independent of the order of the distribution of nerves; that, when thus reflected, it maintains, in one case, the harmonious action of organs, or disturbs that harmony in another, or induces disease in another, or becomes a curative agent in another; according to the nature of the influences which may be exerted upon it.

990½, *b*. Now, therefore, in view of all these things, as well as of what has been hitherto said of the functions of organic life, and of the consequences which have befallen the philosophy and the practice of medicine from the prevalence of the chemical, physical, and humoral doctrines of life, disease, and therapeutics, it is evident that there is nothing of greater importance in medicine than a proper understanding of the attributes of the nervous power, and that it must be regarded merely in the light of a vital stimulus, or a vital depressant, or a vital alterative, and that it has no other participation in the actions and results of animal and organic life.

I have, finally, reserved for this place another demonstrative proof that the nervous power is in no other than the foregoing sense the cause of a single phenomenon in organic beings, and that, therefore, all the causes which bring it into operation, or otherwise affect its pronunciations, exert their influences directly upon the power itself, and that an irresistible analogy is thus brought to concur with the many specific facts in proof of the direct operation of all other vital agents upon the properties of life which are common to plants and animals, and not upon the physical structure (§ 189). I say, then, that, since the nervous system is carried into all parts of the organization of animals, but has no existence in plants, and since both animals and plants possess organic functions in common, and since, also, the organic functions of animals are variously affected through the instrumentality of the nervous system, not only by causes operating directly upon the nervous centres and the trunks of nerves, but indirectly through the circuitous route of the sensitive and motor systems of nerves, and, *especially, farther, since there is no anatomical union whatever between the extreme fibres of the sensitive and motor nerves, nor between them and the fibres or ultimate parts of any other tissue*, it follows as a physical necessity that the organic properties and functions can be influenced through the nervous system only by a real substantive agent which is entirely different from the physical structure itself, and which is capable of extending its influences from one tissue to another between which there is no physical union, and that, therefore, all the primary essential impressions must be exerted directly upon the agent itself. Whence, also, it follows, that all the results which ensue in other tissues, as consequences of the transmission of the nervous influence from the expanded nerves to those tissues, are due to primary impressions by the nervous power upon the organic properties of such tissues, and not upon the physical structure itself. Lastly, it neces-

sarily results from the foregoing demonstration, that the organic properties appertain just as much to a real substantive agent, and are as different from the physical structure, as the nervous power is different.

The foregoing facts and arguments relative to the disconnected state of the nervous and other tissues are equally true of all the tissues respectively, and as true, also, of the organic properties as of the nervous power in the aspect of the anatomical facts (§ 170–185, 190–192, 200, 208, 215, 217, 219, 220, 226, 228, 230, 233, 233¾, 234 *c*, *d*, *e*, *f*, 500).

It is scarcely necessary to add that it does not affect the induction from the physical fact, whether the tissues be separated by minute distances, or be removed from each other as far as the equator from the magnetic poles (§ 234, *c*).

The Experience and Opinions of Distinguished Physicians as to Bloodletting in Inflammatory, Congestive, and Febrile Diseases.

991, *a*. It would not be appropriate to this work to set forth the vast range of experience in favor of bloodletting, in the treatment of inflammatory, congestive, and febrile diseases, which I have explored in the Medical and Physiological Commentaries, and as contributed by men whose genius, observation, and success, will command the admiration of ages. But great controverted questions call for something more than annunciations of opinion, however great the authority, or however those opinions may imply all the requisite experience.

991, *b*. Bampfield introduces his remarks by saying, very justly, that, "In medical science, all reasoning and hypothesis must yield to the results of experience, and deductions from facts. I have employed venesection," he adds, "not only in dysentery, but other internal and external inflammatory complaints in the East and West Indies, with the most happy results. And is it not our *sheet-anchor*, our principal remedy, *in the cure of yellow fever*, when had recourse to within the first eighteen hours of the attack?"

Mr. Bampfield exposes the origin and fallacy of the objections that have been made against bloodletting. He "has been astonished and shocked to find bloodletting in hot climates condemned;"—while others, of the temperate climates, think it only adapted to the tropics, or condemn it universally.

992, *a*. Let us consider, next, the solemn statements of one who is known as the "Ulysses of Medicine," from his vast practical opportunities in numerous climates, as Surgeon-general of the British Army; and let us observe how his experience illustrates and confirms the great principles relative to bloodletting, and the universality of those principles, and their practical application under all circumstances of climate. It should be premised, however, that I have rarely found the heroic practice of Jackson necessary or expedient in its largest extent; and should be inclined to attribute more to the modifying influences of climate in the following cases, were it not that his practice was remarkably distinguished for its decision and success in various parts of the globe, while it is sustained by many of the best observers in every variety of climate. Thus, then, Robert Jackson:

"The end is not attained in many cases, particularly in the more concentrated forms of fever that appear among the military in tropi-

cal climates, at a less expense than eighty or ninety ounces of blood drawn at once." After stating, in another place, that the quantity of blood abstracted in fever, at one time, during the years 1813 and 1814, at the Hospital of the Royal Artillery, was rarely less than three pounds, frequently four or five, and sometimes six pounds, Dr. Jackson remarks that such quantities taken at once "may appear unsafe to some readers. But I am warranted to say, from a retrospect of the whole proceeding, that *no accident occurred in any instance from the most excessive bleedings* that were made; and I may add, that the strength was so little impaired by this apparently revolting practice, that the greater number of persons, who were treated in this manner, *returned to their duty within a fortnight, in the full vigor of health*" (§ 1019, *d*). Such, also, was Jackson's practice in other countries (§ 973 *b*).

992, *b*. Let us also hear Jackson upon the specific point of cerebral inflammation, which demands, as I have said, more than any other disease, a fearless and extensive use of the lancet (§ 974).

"The quantity of blood," says Jackson, "which may be abstracted in cerebral inflammation, without even compromising the safety of the patient's life, exceeds a measure which, were my experience of the fact not clearly ascertained, I should not venture to lay before the public. Four pounds, taken away at one time, may be considered a moderate bleeding in the more concentrated forms; six pounds have been taken on several occasions, and a hundred and twelve ounces at a single bleeding in some. The practice, so formidable in appearance, implied no danger. It saved life by *direct effect* (§ 938 *b*, 955, 1019 *d*). The practice is reasonable in theory (§ 924–934, 942, 944, 948, 949). It is proved in experience to be founded in truth. *The quantity, moreover, is to be measured by the effect which arises under the abstraction, not by an opinion formed under the presumption of what may be right.*"

In some cases of fever attended by cerebral inflammation, Jackson sometimes abstracted a hundred and sixty ounces of blood, or ten pounds (avoirdupois), in a day; and he remarks, in connection with this statement, that, "instead of danger at the time, or debility as a consequence of such extraordinary depletion, fainting did not always occur, and the patient, in *most cases*, returned to his duty within *eight days*" (§ 974).

992, *c*. In the foregoing (§ 992, *b*), as in the concentrated forms of fever (§ 992, *a*), we have a clear exemplification of what I have taught as to the tendency of inflammation to maintain the system against the depressing influence of loss of blood, and that when the brain is the seat of inflammation an exciting nervous iufluence is more powerfully developed, and operates with greater force upon the diseased state of the organ, and upon the heart and whole capillary system, than a similar affection of any other part (§ 480–483, 971–974).

Secondly,—"The quantity," says Jackson, "is to be *measured by the effect* which arises under the act of abstraction, not by an opinion formed under a presumption of what may be right. *Whatever be the quantity, it is the effect produced which constitutes the* RULE *for guiding the measure.*" I have thus repeated this doctrine, for it is the most important that can be found in the annals of medicine. This rule is universal, and it is for this reason that the best practitioners never sug-

gest tne *quantity* of blood which should be abstracted in any given form or case of disease.

Thirdly,—" Instead of debility, as a consequence of such extraordinary depletion," says Jackson, " fainting did not always occur; and the patient, *in most cases*, returned to his (military) duty *within eight days*, in the full vigor of health" (§ 1019, *d*).

What an admirable illustration is this of the fallacy of the temporizing practice, or the more sad effects of the stimulant treatment! How forcibly it evinces the importance of making a decisive impression, at one blow, in all grave inflammations! How truly does all this proclaim the existence of peculiar properties of life, in whose alteration the essence of disease consists, and whose restoration is effected by the direct impression upon them of loss of blood! How forcibly does it refute the humoral pathology, and that not less erroneous assumption that disease is constituted by some positive change of structure, or the yet more glaring fallacy that it consists in debility!

992, *d*. I have said that it has not often fallen to my lot to carry out Jackson's practice, excepting in principle (§ 992, *a*). This may be owing, in part, at least, to the fact of having commonly enjoyed the opportunity of applying remedies at the early stages of disease. Where I have found the full extent necessary, it has been mostly among children; estimating the ratio of the loss according to the relative ages and size. The most remarkable example has occurred in the case of my only child; whose general history of health is stated in the Commentaries for another purpose (vol. i., p. 693).

Not long after his very protracted disease had given way, and being at the age of nine years, he was suddenly and violently attacked with well-marked inflammation of the brain, lungs, and small intestine. I raised him to an erect posture, and bled him till syncope came on. The symptoms gave way; but, in six hours afterward, those of the brain, and, in an inferior degree, of the lungs and intestine, had reappeared. I then bled him again, in the same posture, and to the extent of syncope. Before exhibiting any medicine, I still awaited the ultimate effect of the loss of blood. The cerebral symptoms gradually presented themselves again, and I bled him, for the third time, as before, at the expiration of about twelve hours after the second bloodletting. Soon afterward, I gave him one tea-spoonful of castor oil, which completed the direct course of treatment. In two days after the last bloodletting, I took him upon the rail-road a distance of five miles, and returned (§ 955 *b*, 958 *a*). It may be worth adding, in connection with my former statements relative to his extreme infirmity of health during the first seven years of his life, that he has enjoyed a very robust constitution since the illness described in this section; being now seventeen years of age (§ 870 *aa*, 892$\frac{4}{5}$ *i*, 974).

The quantity of blood abstracted in the foregoing case was very large at each abstraction, and exceeded, in the ratio of the age and size of the subject, what I shall have recorded of the experience of others.

993. The experience of Moseley corresponds with that of Jackson, and where the remedy had been apparently of ample extent, he remarks that, " it has frequently happened in the fever of the West Indies, that accidental bleeding from the orifice when the patient had

fallen asleep, to far greater quantities than has ever been directed to be taken away, has carried off the fever entirely, and the surprise on discovering a profusion of blood in the bed has been changed to joy for the alteration produced in the patient" (§ 973, *b*).

There are few practitioners of much experience who have not witnessed similar events (§ 1019, *e*).

994, *a*. And how well is all this sustained by Dr. Rush, who has "always observed that the cure of a malignant fever is most complete, and the convalescence most rapid, when the bleeding has been continued until a paleness is induced in the face, and until the patient is able to sit up without being fainty." "Bleeding," he adds, "should be repeated while the symptoms, which first indicated it, continue, should it be until four fifths of the blood contained in the body are taken away;"—being conformable to the precept of Celsus, that "*We must not run from one remedy to another, so long as that remains which was there at first*" (§ 1007);—or, as Porter has it, "*it is not sufficient to diminish an increased action, unless the constitution be kept, until the period of danger is over, in a condition that will render a renewal of that action unlikely to occur*" (§ 954, *b*).

994, *b*. The same result of an almost unsurpassed experience is again and again reiterated by Rush. "The half-way practice of moderate bleeding," he says, "has kept up the mortality of pestilential fevers in all ages and in all countries. It is much better not to bleed at all, than to draw blood disproportioned in quantity to the violence of the fever (§ 960, *b*). Bleeding must not be discontinued so long as the symptoms which first denoted its necessity continue."

In very prostrating forms of fever, he says, that "bloodletting lessened the sensible debility of the system. Hence patients frequently rose from their bed, and walked across the room, a *few hours after the operation*" (§ 569 *e*, 898, 992).

995. And so, also, Armstrong: "In pneumonia," he says, "bleed your patient to approaching syncope; otherwise, instead of benefiting him, you will *do him harm*" (§ 960, *b*).

And again: "In inflammations of the serous membranes, or of the parenchymata, I bleed," he says, "more decidedly than I ever did." "I have treated nearly three hundred cases of severe *enteritis* with bleeding, &c., and with a success far greater than I have heard from any other plan. There is no success on record at all comparable with it" (§ 1005, *e*, *i*).

996. And so Mr. Lawrence, who says, that,

"In cases of inflammation, where the blood comes freely out of the vein, I generally let it run on till it stops; for that seems to me the only way of doing good" (§ 960).

997. Wardrop, in his excellent work on Bloodletting, lays down the same rule and the same experience. Thus:

"When a large quantity of blood is not taken away at the first bleeding, in inflammation, or at a second depletion quickly succeeding, I have generally found that, on all future occasions, it is seldom practicable to abstract any considerable quantity, however necessary it may appear; and thus it is, that when copious bleedings are not employed at the commencement of the treatment of inflammatory diseases, and if the patient afterward recover, it has generally been from the employment of a great number of bleedings. Moreover, it is *only*

in such cases wherein the *pernicious effects* of bleeding are exemplified" (§ 950). "There seems always," he says, "to be a disposition in patients, as well as in medical men, to economize blood" (§ 960, 1007 *b*).

997, *b*. It is an aphorism with Gregory, that, in severe inflammations and fevers, "the danger of a large bleeding is less than the danger of the disease."

998. "With gangrene, infarction, and abscesses in prospect," says Beddoes, "transient syncope, from loss of blood, is a slight evil. The *rule, that the constitution recovers much more kindly from debility by bloodletting than by disease*, affords great encouragement" (§ 569, 1007 *b*). "Numerous facts show that in high inflammations the lancet can scarce be used too freely."

999, *a*. Jackson says that "Dr. Rush carried subtraction of blood to a great extent in yellow fever; but the quantity subtracted was obtained by repeated subtractions, not by abstraction at one time. The mode of depletion was not abrupt, such as arrests disease by force, and such as I have in view in the present history" (§ 929–934, 938 *b*, 942, 944, 948, 949, 955).

999, *b*. It may be true that Dr. Rush sometimes fell short of the proper effect. It may be true that his moral courage was unequal to that of his great cotemporary, since each was extensively denounced as "a murderer;" and Rush could hardly fail of being sometimes embarrassed by his strange delusion that "debility is the universal predisposing cause of disease." Nevertheless, a glance at a preceding section (§ 994) will assure us that the general charge is without foundation. His philosophical acumen led him to bleed extensively, and with success, in many cases where there appeared no hope to others but in powerful stimulation. There is also a distinction to be made between the yellow fever of Philadelphia, and that which called forth the heroic practice of Dr. Jackson. The prostration of the heart from intense sympathetic influences reflected from the vessels engaged in the morbid processes was often greater, and there was less active inflammation to sustain decisive bloodletting, and more of venous congestion to diminish the tolerance of loss of blood, and to impart malignancy to fever, in the former, than in the latter instance. Nature, therefore, frequently interposed an obstacle which compelled the American philosopher to be sometimes content with small and repeated abstractions of blood (§ 974, 975, 977, 983, 985).

999, *c*. The foregoing reference to Rush's doctrine of "debility" (§ 999, *a*) leads me to an extension of a preceding section, where I have explained the acceptation in which I employ the term *prostration* (§ 961, *b*), and which goes with former sections in elucidating the nature of that condition which is commonly mistaken for "debility" (§ 487 *h*, 569). What I now purpose saying is, that the condition of the heart takes a very large share in those morbid demonstrations which have led to so many theoretical and practical errors. But, the heart, in these cases, is mostly obedient to disturbing influences propagated upon it by the instruments which are carrying on the morbid processes, and where the powers may exist in a very exalted, though, also, otherwise modified, state. Those extreme vessels, however, determine upon the heart a prostrating nervous influence, and often, also, an accumulation of blood about its right cavities, which contributes yet farther to the embarrassment of the organ. This will be readily ap-

preciated from what has been variously said upon relative topics in former sections; but the whole principle may be seen by referring to the instrumentality of the nervous power in the operation of loss of blood; while, also, the philosophy which is there set forth borrows a corresponding illustration from the subject embraced in this section (§ 916–922, 929–938, 942–949).

The heart, being prostrated in the foregoing manner, increases, by reacting sympathies, the morbid state of the instruments of disease, complicates all the phenomena, and does its large part in leading all but those who will take the trouble to investigate the philosophy of life, and analyze the symptoms of disease, and apply them critically, according to the share which belongs to each tissue and organ, to rest their intellectual efforts upon *the symptoms* alone, and their hopes in tonics and stimulants. But, he who will penetrate this seeming labyrinth, yet accessible to all, will discover, at once, that the remedies should be addressed to the immediate instruments of disease, and that whatever will bring relief to these will certainly relieve the heart, and dissipate the phantom, debility; while, on the other hand, every cause that may increase that pathological state of the instruments which are the absolute seat of difficulty and danger, will as surely engender, sooner or later, increasing embarrassment of the heart, and a consequent multiplication of the morbific influences which radiate from the centre of the circulation (§ 892 *c*, 965 *b*, 966–968).

1000. Few medical philosophers have done so much for therapeutics as Sydenham; and with his name is associated one of those great revolutions in practice in which bloodletting is the foremost remedy. There was then, as now, that timid caution which has contributed so largely to the common prejudice against the abstraction of blood.

"Nothing," he says, "is more frequently urged as a capital argument, by those who condemn bleeding, than the mischief which arises from bleeding in an improper manner" (§ 892 *a*, 892¼ *c*, 960 *a*, 1005).

1001, *a*. The "improper manner" to which Sydenham refers (§ 1000) is justly, however forcibly, expressed by Botallus. Thus:

"Bleeding does no service in many cases, either because persons have recourse to it too late, or use it too sparingly, or commit some error in both these particulars. But, if our fears be so great, and we take away so small a quantity of blood, how is it possible to judge what good or mischief bleeding may do? For, if a disease which requires the loss of four pounds of blood for its cure, and yet but one be taken away, destroy the patient, it does not therefore prove destructive because bleeding was used, but because it was employed in an improper manner (§ 950, 965 *b*). But ill-designing and indolent men endeavor to lay the fault to the bloodletting; not because it did really do mischief (otherwise than by its improper use), but because they desire to give every body an ill opinion of it. Or, suppose they do not do it from wickedness, they cannot be excused from ignorance and perverseness." It is also his opinion that "one hundred thousand men perish from the want of bloodletting, or from its not being timely employed, where one perishes from excessive bloodletting, *when practiced by a physician*" (§ 1005).

1001, *b*. Botallus was critically right in qualifying his remark by adding, "when practiced by a physician." No little of the prejudice which rational medicine encounters arises from the former indis-

creet use of the lancet, in the hands of the surgeon, immediately after concussions from falls, &c. The sad experience of some of the most able has led to admonitions like that which is recorded in a former section (§ 960 *a*, page 720; § 1007, *b*).

But shall *physicians* deliberate when inflammation is careering in the great organs of life? Can there be a question of the applicability of bloodletting to phrenitis, pleuritis, peritonitis, pneumonia, and to many other grave inflammations, under their ordinary circumstances? It is true, we have lately seen practitioners, Dr. Dickson, for example, boasting of their success without having "ever wetted a lancet." But I do not believe that this exclusive practice has many open advocates; and to admit its imputed results would be to renounce the dictates of our own and of common observation. A more limited opposition, however, to bloodletting in grave inflammations is making an inroad upon former experience; nor is it the least remarkable circumstance that it enlists the most able disciples of the anatomical school. And although they may often admit the utility of the remedy in a general sense, when they come to its practical application to particular diseases, we are told that it is either useless, or prejudicial (§ 960).

1002, *a*. But once more, as to the prostrating forms of fever, from which it will farther appear that neither the yellow fever, nor others of an analogous character, have been so modified by climate, seasons, &c., as to preclude the abstraction of blood; and that if loss of blood be demanded by simple inflammation, it is much more so when inflammations are complicated with idiopathic fever, and especially when that fever is of a "malignant nature," and constantly imparting its malign influence to the local developments (§ 999, *b*).

Dr. Stevens, of the West Indies, the celebrated advocate of the saline treatment of fevers, affirms, in his late work on the Blood, that, "Those who were well bled, in the yellow fever, and properly evacuated in the beginning, almost invariably recovered." "He took blood till he had nothing to fear from increased action." I have introduced this statement for the purpose, also, of showing that the credit which he imputes to the saline treatment of yellow fever is wholly due to the decisive bleeding and purging which he adopted. The saline practice in fevers was pretty largely in vogue some centuries ago, and has been lately brought forward to give plausibility to the humoral doctrines.

1002, *b*. Mr. Evans recently states, that in the Indies "we bleed largely in the yellow fever, repeating the operation in two hours, if there remain the slightest pain on pressing the epigastrium; and, in general, if any gastric affection remain after the second bleeding, toward the close of twenty-four hours, we repeat it a third time, and apply the leeches afterward."

This practice, as I learned on a visit at different islands a few years ago, prevails throughout the West Indies; and, in Eastern India, it is well known that bloodletting was never in higher repute in all congestive fevers than at the present day.

1002, *c*. Baker remarks, that it is necessary to abstract, by repeated bleedings, twelve or more pounds of blood in the malignant fevers of Brazil. The distinguished Hillary urges free bloodletting on the first and second days of yellow fever, and in the worst forms of the disease.

1002, *d.* "Here is a case," says Mills, "of the typhus gravior of Cullen, or such as is commonly denominated putrid. The petechiæ (so much dreaded by the opponents of bloodletting) disappeared after the second bleeding; an effect I *daily* witness from the use of the lancet, which clearly proves that this symptom proceeds from vascular action." And so, also, Dr. Parry; who introduced the only successful or philosophical treatment, that of bloodletting, in purpura hemorrhagica.

1002, *e.* By the same process of induction from the vital phenomena that conducted Parry to the true pathology of purpura hemorrhagica, Lind, Blane, Milman, Rouppe, Fordyce, Girtanner, Pinel, Baglivi, Heberden, De Haen, Moore, Bampfield, Darwin, Beddoes, Woodall, and others, inferred the inflammatory nature of scurvy (the great pillar of humoralism), and practiced bloodletting as the first step in its treatment.

1002, *f.* What shall be said of the celebrated jail fevers, where every body now stimulates? Let us hear the illustrious Pringle, who, more than any one of the old school, taught the pathology of living putridity. He was one of the last of a long line at whose beginning stands the Roman projector of humoralism; having died in 1782, when solidism again triumphed for awhile. He was a man of vast experience, great success, and of universal renown. He was an English baronet, professor, physician-general of the British forces, and studied and treated diseases in Edinburgh, Flanders, Scotland, London, &c. He was, in brief, like Robert Jackson, a "Ulysses in Medicine," and, like Jackson, he found that the same diseases required the same general treatment in all climates; being utterly regardless of the humoral doctrines at the bed-side of disease.

Pringle, I say, bled in all forms of fever—jail fever, typhus syncopalis, and whatever the imaginary degree of putridity. "Bleeding," he says, "in *putrid* fevers, is indispensable." "It is the first thing to be done in the beginning of the treatment."

Riverius, an eminent French physician of the seventeenth century, like Pringle, considers "*putridity* a reason for bleeding at all stages of petechial fevers,"—"*non ullum unde eminere periculum*,"—*nor did any injury result from it.*

Grant says that, "even in the *putrid diathesis* of fevers (as he calls it), where much evacuation is required, more or less blood ought to be taken before proceeding to other evacuations."

Baillou, in the enlightened days of humoralism, advises "bloodletting in all *putrid* and malignant fevers, even when there is a tendency to hemorrhage from *dissolution* of the blood" (§ 1002, *c*). And so of many other distinguished theorists in the school of putridity.

1003. Let us now regard the language of the best experience as to the treatment of a form of fevers for which "bark" is commonly supposed to be an almost unfailing specific, but which, even its alkaloids, often entails the most obstinate forms of local chronic disease, when untimely, or excessively, employed (§ 892, &c.). Thus:

"It may be laid down," says Armstrong, "as an established principle, that if venesection does not absolutely cure intermittent fevers, it paves the way for other remedies, and is, on that account, highly necessary." Or, as Hippocrates has it, "*he who would purge bodies, must first make them permeable.*" Baglivi, Torti, and other distin-

guished Italian physicians, affirm, positively, that the local complications of their intermittents could not be cured without bloodletting Sir John Pringle, in treating the intermittents, mild or malignant, in "low, marshy countries, found it necessary to begin with opening a vein, and to repeat the operation according to the urgency of the symptoms." "A person," he says, "unacquainted with the nature of this disease, and attending chiefly to the paroxysms and remissions, would be apt to omit this evacuation, and to give bark prematurely." This is what led Cleghorn into his fatal mistake (§ 1005, *h*). But we ultimately hear from him, that, "for his part, when called early enough, he used to take away some blood from all people, of all ages, when affected with tertians, unless there was a strong contra-indication." And so Senac: "the physicians bleeding five or six times in an epidemic tertian." Cragie says, that, in Great Britain, remittents require the loss of twenty-five to thirty ounces of blood (§ 960, *a*).

1004, *a*. It would be superfluous to extend the foregoing species of testimony afforded by modern practitioners in favor of bloodletting in the treatment of inflammatory, congestive, and febrile diseases. In the article on Bloodletting, embraced in the Medical and Physiological Commentaries, I have presented the experience of most of the distinguished practitioners from the earliest ages of philosophical medicine, and it may be there seen that the most distinguished have concurred in their testimony as to the remedial nature of bloodletting.

1004, *b*. The "father," himself, says, that, "in all active inflammations we should open a vein, and if the disease be vehement and prostrating, the loss of blood will bring strength to them that lose it,—'*robur ipsis affuerit.*'" He abstracted blood for the relief of those syncopes which attend the worst forms of congestive typhus; as did, also, Galen, Celsus, Aretæus, Trallian, Paul, Aurelian, Avicenna, &c.

1004, *c*. Oribasius, about three hundred years B.C., records the first statement of the quantity of blood abstracted. It was taken from himself, to the extent of two pounds, and cured him of the plague. Galen bled largely in this disease, and he is the next who records the quantity. "I remember," he says, "to have taken away in some instances, at one bleeding, six pounds of blood, which immediately extinguished the fever, *nor was there any loss of strength in consequence*" (§ 992). Such was his success by this mode of treatment, that the spectators exclaimed, *εσφαξας, ανθρωπε, τον πυρετον*;—"Oh! man, thou hast cut the throat of the distemper." Avicenna says that he has sometimes abstracted, in the plague and "putrid fevers," at one bleeding, five or six pounds of blood,—"*quinque aut sex sanguinis libræ auferantur*" (§ 1019, *d*.) Bleeding largely in the plague was a general practice after the revival of learning, and was practiced through the 16th, 17th, and 18th centuries; as it was, also, in other fevers, and in inflammatory and congestive affections. The exigencies of the disease was the criterion as to the quantity of blood to be abstracted. Septalius states that it was the universal custom of physicians to bleed in the plague of 1575 and 1576. "*Communi consensu in hujusmodi nobile remedium nullo modo pretermittendum esse decreverant.*" And so Riverius, of a similar epidemic, "*Deo sit laus et honos! quotquot hoc tractali sunt modo feliciter evaserunt!*" In later times, Faulkner commends bloodletting in the plague, and says that "when the blood was in a dissolved state, the remedy was not less

favorable." Assalini remarks, that, "At the commencement of the plague, I saw the necessity of making use of bleeding, in proportion to the strength of the patients."

And, as to the less prostrating forms of fever and inflammation, Baglivi supplies an example of the general practice in the 16th, 17th, and 18th centuries. He observes, "Omnes acutas et inflammatorias febres, hic Romæ, curare incipio per sanguinis missionem." And so of all the eminent Roman physicians down to the recent day of Rasori.

1004, *d*. It has been often thought remarkable that Hippocrates had never designated the quantity of blood which may be demanded by any given form of disease. The reason is, he was too much of a philosopher. He knew that no rule, in this respect, would be useful; but, on the contrary, unwarranted by nature, and liable to the worst results. Look at his writings, and you will find him bleeding according to the symptoms, and the general history of the case. This, indeed, he often says, was his *rule*. He had no other in relation to quantity.

1005, *a*. Before leaving these practical considerations it may be well to listen to the confessions of a disastrous experience which befell some of the most enlightened of our profession, from their neglect or misapplication of bloodletting. Let us select examples of prostrating forms of disease, where it too commonly happens that its nature and exigencies are misapprehended, or imperfectly understood, and where "debility" is regarded as the essential pathology, and is supposed to demand the stimulant plan of treatment. These examples will cover the whole ground, and disarm the stoutest prejudice in other less terrific forms of prostrated strength.

1005, *b*. The distinguished Mr. Hey shall speak first, and of those cases of puerperal fever in which "debility" presents its most appalling aspects. This able man had unhappily treated the disease either with tonics and stimulants, or with inadequate bloodletting. He finally introduces a case (his ninth case), which was the last in which Mr. Hey employed the bark and wine, or procrastinating, treatment. It was the last mistaken act that divided the professional life of Mr. Hey into two distinct eras. The patient died, and with her death came his full conviction of his error. "If the disease," he says, "is clearly ascertained, no other consideration is of much importance. The state of the pulse affords little information, either as to the propriety of bleeding, or the quantity of blood to be taken away; and if we are deterred either by the apparent weakness of the patient, by the feebleness and frequency of the pulse, or by any other symptom, from bleeding *copiously, we shall generally fail to cure the patient*."

1005, *c*. And now mark another maxim of this able man, who felt his way to truth over many a victim of malpractice; and what he says of puerperal fever is equally applicable to all other fevers, when complicated with inflammation or venous congestion. "There is a vast difference," he says, "in the puerperal fever at different times, and in different situations and circumstances. In some cases, it appears like a phlegmonous inflammation; in others it destroys with more rapidity and certainty than the plague. But, the means of cure are precisely the same in both; but in the worst forms the measure of bloodletting *is greater and less limited*, and the period within which it must be employed is far more circumscribed." "The truth is," he says

(still lamenting his mistakes), "that bloodletting has seldom been fairly tried. Either the quantity of blood taken away has been too small, or the time when it was taken too late for any use; and thus the principal remedy for the disease has been brought into disrepute" (§ 965 *b*, 1000, 1001).

1005, *d*. But Mr. Hey was mistaken as to the novelty of the practice. Like many others, he depended too much upon his own genius and experience; neglecting the past, and thinking that medicine is the work of a day. Hence his ignorance of the labors and of the choice experience of his predecessors. Bloodletting had predominated, as the only great remedial agent for all inflammatory affections and fevers of the most depressing character, ages before Mr. Hey came to illustrate the truth by other martyrs; and this in England, Germany, Arabia, Italy,—the island of Cos (§ 1004, *b*). The "disrepute" of which Mr. Hey speaks was then only local, not general; for, while the temporary reign of the "bark and wine treatment" crippled the best practitioners in Great Britain, reason and sound practice were unrestrained in other countries.

1005, *e*. The equally able and distinguished Mr. Gordon had the same melancholy experience with bark and wine, and the procrastinating treatment of puerperal fever; and, like Mr. Hey, he shifted his practice to early and copious abstractions of blood, and has left a record of the happy fruits of his dear-bought knowledge. He has one remark which proves the inutility or the positive injury of inadequate bloodletting. "He lost," he says, "EVERY patient when he bled only to the extent of ten or twelve ounces; but that ALL recovered when he had the *courage* to abstract twenty or thirty ounces" (§ 950, 965 *b*). Armstrong, by "copious bloodletting, lost only five out of forty-three cases."

1005, *f*. And here is Denman, the eminent author of works on Midwifery, who, like Hey, and Gordon, had carried havoc into the chambers of puerperal women. He, too, once bowed at the superstitious idol, "Debility;" but having lost most of his patients under the seductions of this *ignis fatuus*, he turned himself to the Genius of philosophy, and, as a noble atonement to mankind, left behind him, like Gordon, and Hey, a record of his errors.

"I am now convinced," he says, "by *manifold experience*, that my reasoning was fallacious, and my facts groundless, and that which I had considered proofs of the insufficiency, or the impropriety, of bloodletting in puerperal fever, ought, in reality, to have been attributed to the *neglect* of performing it in an efficient manner, and at the very beginning of the disease" (§ 1000, 1001).

1005, *g*. Leake says that, "every puerperal woman, in Lowder's time, who was blooded, died; ten ounces being considered a large bleeding;" while Leuret, accustomed to the timid practice of Lowder, affirms that, "he had never seen a woman escape after bleeding." Here it will be readily perceived that the inefficient bloodletting aggravated the disease (§ 950, 965), just as it is allowed to have done, in the same affection, by Hey, and Gordon, and Denman.

1005, *h*. With the familiar name of Cleghorn are associated, as in the former instances, a sound judgment and large experience. Let us consider his experience in a pestilential, prostrating, bilious pneumonia that ravaged the island of Minorca; and let us not fail of being

admonished by his example, also, of the importance of taking for our guide the lofty principles of our science, and the experience which is taught by adversity as well as by happier auspices.

This epidemic pneumonia was complicated with idiopathic, congestive, fever, attended by "insidious intervals and treacherous remissions," and by great prostration, or "debility" (§ 569). And now mark the vacillating treatment so characteristic of weaker minds, or where ignorance of medical philosophy leads to an obstinate perseverance in the suggestions of prejudice and timidity. Mark, also, the uselessness, or the injury, of small abstractions of blood, and the triumph of greater (§ 950, 965, 1000, 1001).

"I attempted," says Cleghorn, "to cure the patients by bleeding once or twice a day, except during the *insidious* remissions; but they *generally perished.* This unforeseen event startled me greatly, and led me to review the whole progress of the disease," &c. He then determined "to adopt the advice of Duretus, and to use the lancet with more caution." But his failures became still more frequent and mortifying.

"At length I was convinced," he says, "that instead of too much, too little blood had been taken away in the beginning, and that I had been *misled by the insidious intervals.* I then began to bleed more plentifully, taking away thirty or forty ounces within the first three days of the distemper. This method succeeded well in several of the cases" (§ 965, *b*).

Still he was not satisfied. "At last," he goes on, "about the middle of March, when the disease raged with the utmost fury, having found that there was the most absolute necessity for bleeding largely without delay, *in order to preserve life,* I began to put in practice the following method of cure, WHICH SELDOM OR NEVER FAILED; not only in young, robust people, but even in those of more *advanced age,* provided I saw the sick before *the end of the third day.*"

This "method" consisted in abstracting blood in the horizontal posture, "till the pains abated or the patient began to faint; taking from eighteen to twenty-seven ounces, avoirdupois. If the symptoms continued, *a few hours afterward* the same quantity was again taken away, without regarding the state of the blood, &c. Next morning, if there were *any remaining symptoms,* the bleeding was repeated, and the blood carefully weighed. From fifty-four to sixty ounces were frequently taken away during the first twenty-four hours of attendance. *If any symptoms returned,* the patients were *immediately* bled again to the amount of fourteen or twenty-seven ounces."

What a contrast in treatment,—what a contrast in results! Bloodletting, decisive bloodletting, was at last almost the only remedy employed, and it now succeeded in every instance where its timid application had been, before, as universally fatal (§ 950, 954 *b*, 965 *b*, 1000 1001).

And here let us not fail to observe the same results in the practice of Cleghorn, as in that of Jackson and others in analogous epidemics (§ 992–999). "Under this method of treatment, it was remarkable," says Cleghorn, "to observe how rapidly the sick recovered their usual health and strength, notwithstanding the great loss of blood which they had sustained; while many, who had been bled more sparingly, continued in a languid, infirm state, for *some months.*" Patients of the lat-

ter class were only imperfectly relieved. Congestion still remained about some of the great viscera, especially the liver, by which, also, the powers of digestion were maintained in a prostrated state. Under these circumstances, errors in diet, and mental and bodily fatigue, often contribute to maintain and exasperate the consecutive derangements; till, at last, it frequently happens that a slow increase of the local diseases becomes the exciting cause of another explosion of the constitutional malady. Thus the patient not unfrequently goes on revolving, year after year, through mitigated and exasperated conditions of disease, which more decisive treatment by bloodletting, at its onset, would have prevented (§ 868, 883 *b*, 892 *d*).

I have stated the several successive steps of Cleghorn's plan, that each may be compared with the others. The quick transition from wrong to right evinces the hand of a master. The record is full of the most important instruction; and while I hold it up to the present generation, I would that not only its practical instruction, like the sad experience of Gordon, and Hey, and Denman, should be duly regarded, but equally, too, that the frankness of each should be emulated.

1005, *i*. Dr. Boyd, also, subsequently to Cleghorn's time, in describing the malignant fever of Minorca, states that bloodletting must be carried to the extent of positive relief, without reference to quantity. He sometimes repeated the operation four times in a day. Our inland practitioners, at the south and west of New York, will see in the congestive fever of Minorca a simile of their own as sometimes complicated with "bilious pneumonia;" while their practice responds more or less to that of Boyd and Cleghorn.

1005, *j*. Erysipelas is another wide-spread and prostrating disease in its epidemic form, which has beguiled the multitude into the fatal use of "the bark and wine treatment." In his Essay on Bloodletting, Dr. Wardrop states that, "during a long attendance at a public hospital, a certain physician had never known bloodletting employed in erysipelas, and that nearly all the cases that he had seen of that disease, affecting the head and face, had terminated fatally." And so Armstrong: "The wine and bark system is of all the most fatal practice in erysipelas." "Five individuals had erysipelas in one house, were treated with bark and wine, and all died" (§ 995).

When "erysipelas" presents itself as an epidemic, it displays its connection with a far graver form of disease in the abdominal viscera; especially hepatic congestion. And such, probably, is always its complications when sporadic only. But, *the symptom* is conspicuous; and hence the name, and hence, also, the usual treatment. The attention is apt to be turned, mainly, to the sympathetic inflammation of the skin. The obscurely marked, or what Cleghorn would call the "insidious," affection of the liver, &c., is not appreciated, and the force of the treatment, therefore, too often takes the wrong direction. Nothing, indeed, is more common in "epidemic erysipelas" than an absence of the cutaneous affection in the worst forms of the disease; and these very cases, from their exact resemblance in all other respects to those which are marked by *the symptom*, go by the same name, and get the same treatment. I have seen many instances of this nature; particularly during the late prevalence of the disease in Vermont and New-hampshire. I have seen their subjects fall victims to the disease within two and three days from the attack, where there was no inflammation

of the skin; and, in other instances, where the skin was mottled with patches of a low degree of inflammation. I found the practitioners, however, generally taking the right course, and regarding the affection of the skin as symptomatic only. But, the disease presented itself in a very grave form; and it was interesting to observe that, while it had many victims under opposite modes of treatment, the greater success of the depletive plan generally won over the few who had preferred stimulating (§ 689 *l*, 861, 894, *mottoes*, 905½ *b*, 961 *b*, 964 *c*. Also, *Med. and Physiolog. Comm.*, vol. ii., p. 603–607, *Article* ERYSIPELAS).

1005, *k*. Let us consider, also, the adverse results of the stimulant, and even of the tartar emetic treatment of pneumonia (§ 892⅘, *g*). It is the opinion, for example, of Dr. Stokes, that "*General bloodletting is not to be considered the chief means of removing the disease.*" "In the typhoid form, the *best practice is to use wine* in conjunction with local bleedings." "General bloodletting," he says, "is to be used *with extreme caution*, and the vital forces are to be carefully supported." But, "*In two instances only has he seen pneumonia cut short by bleeding*"! This admission appears to be conclusive against the doctrine of "saving the vital fluid," according to this distinguished writer, and especially that of "supporting the vital forces by wine" (§ 569 *e*, 983).

Dr. Williams, in his work on Diseases of the Chest, appears to have enjoyed as little success in the treatment of pneumonia, and for the obvious reason that he considers "local depletion the utmost that can be attempted in typhoid pneumonia. Considerable advantage may, under these circumstances, be sometimes obtained from *dry cupping* on the chest, which, for a time," he thinks, "tends more effectually than even bloodletting, *to draw* the fluids from the congested organs, while it does not *waste the blood* from the system" (§ 960). This philosophy has numerous admirers, who regard it, with Dr. Arnott, as "a great modern improvement in the healing art," and as one of the luminous proofs that the nineteenth century has witnessed a great revolution in medicine; or, as Louis has it, that "medicine is now in its infancy." Apropos, of this distinguished Frenchman, who is opposed, mathematically, to the abstraction of blood in pneumonia, erysipelas, "typhoid fever," and acute intestinal inflammation; with their complications, also, of other local inflammations. And so, too, of many other distinguished French physicians, who rely mainly on the watching system, or on the tartar emetic practice. But, what are the results? Chomel makes the average mortality from pneumonia, at the hospitals, one in four; Louis lost one in three; and Legarde one in three. Leconteulx reported twelve out of thirty, by the antimonial treatment. These last were treated by Laennec.

But, in these United States, where bloodletting is thoroughly practiced, the loss does not exceed one in twenty to twenty-five. There is here, however, no exclusive system, no "numerical method;" but the treatment proceeds upon Hippocratic principles. The symptoms, and various other circumstances, attending each individual case, regulate the practice. It is not all bloodletting, nor all tartarized antimony. Cathartics, calomel, blisters, &c., form as well a part of the treatment. Nor have we much knowledge of the effects of bloodletting in the advanced stages of the disease; mainly for the reason that we adopt it early.

It is said by Dr. Osborne, in his work on Dropsical Diseases, that "Since what has been termed the tartar emetic treatment has been introduced into Great Britain, and the practice of bleeding has consequently been to some degree discouraged, it appears to me that the advanced stages and fatal terminations of pneumonia have been frequent; and in this judgment I am confirmed by records on the large scale" (§ 960, *a*).

1005, *l*. As to any modifying influences from climate in England, either in respect to pneumonia, or other inflammations, or all the varieties of fever, we have only to consult such authors as Armstrong, Jackson, Johnson, Wardrop, Elliotson, Lawrence, Smith, Davies, Weatherhead, &c., &c., to be convinced that those diseases are now, as ever, the same there as in America, and require the same general plan of treatment. Looking back to the age of Sydenham, and along the intermediate periods, we find that every thing, on this subject, has remained without any essential change. It is practice alone that has fluctuated. And, if we cast our recollections through the vista of time, over various countries, till we reach the age of Hippocrates, we shall still find that diseases, of a given denomination, have been the same, and have ever required the same general treatment.

1006, *a*. From what has been now said, under the present division of my subject, and more especially from the wide range of experience presented in the *Medical and Physiological Commentaries*, it appears that there is one universal consent among the great physiological practitioners as to the importance of decisive bloodletting in all forms of active inflammation, and in high grades of fever; whether it appear in the shape of the plague, of yellow fever, of typhus, or other inflammatory or congestive forms. It has been so from the earliest days of the science; in all countries, in all climates, in all constitutions, at all ages; and, whether in the Mediterranean or the Caribbean Isles, the jungles of Asia, the pestiferous regions of Africa, the paludes of Italy, or the high, and temperate, and salubrious countries of Europe and America, we witness the immutable principle that diseases and their general method of cure are every where nearly the same. Constitution, habits, and age, certainly modify the details of treatment, more or less; climate comparatively little. The great fundamental laws of disease remain without change, as do, also, the leading conditions of disease. We have all that Hippocrates described before our own eyes, and we are astonished at the identity. We think him, at one moment, a prophet; and when, at the next, we realize a simple narrative of only what he observed, we are either amazed at his sagacity and philosophy, or that we should have been so slow to have discovered the truth ourselves.

1006, *b*. The human constitution, its laws, susceptibilities, &c., are, in a general sense, every where the same; while the remote causes of disease are the same now as at the beginning of time, produce their effects upon the same properties, whose nature cannot be permanently affected (§ 180–182, 286), and whose results are connected by a chain of analogies. The pathology of inflammation, or of simple or congestive fever, therefore, is the same, respectively, in principle, at all times, and in all countries, and the great principles of treatment must also be immutable. But, modifying causes impart various shades of difference to every epidemic, to every individual case. To under-

stand the complex, or even simple condition of each case, what its general nature, what peculiarities may arise from various causes, what the exact adaptation of remedies, how much the successive changes may be due to nature or to art, requires unceasing vigilance.

1006, *a*. And now let me ask, whether the vast experience, and the precepts relative to bloodletting, of the able physicians who have given to medicine its rank and dignity, are to be impugned by chemists, or by the prejudice, or the limited, or the careless, observation of many physicians, who are too apt to deceive themselves into the belief that they imbody the only experience which can be available in disease, or which enlightened philosophy can approve (§ 1007, *b*)?

Doubtless, it will appear absurd that I should have embraced the *chemists*, and as foremost, too, in the preceding interrogatory. But, is it not the order of the day (§ 5½ *a*, 349 *d*, 960 *a*, page 719)? And being so, I will reply, once more, in the language of Dr. Paris, when he was defending medicine against the harmless recreations of the Chemists, about the year 1825, and mainly because Professor BRANDE had ventured upon the open opinion that chemistry was neglected in medical education, and that the "*London Pharmacopœia is a record of the want of chemical knowledge where it is most imperiously required.*" The answer, perhaps, is abundantly set forth in a former section (§ 676, *b*). As showing yet farther, however, the instability of science, and as embracing a precept which every lover of truth will do well to ingraft upon his morning prayer, I shall quote Dr. Paris once more, though upon a subject simple in its nature, and of very minor importance to that which is relative to the laws of organic life and the great principles of medical science. Thus:

"I cannot conclude these observations upon Mr. BRANDE's attack, without expressing a deep feeling of regret, that a gentleman, whose deserved rank in society, and whose talents and acquirements must entitle him to our respect, should have condescended to countenance and encourage *that vile and wretched taste* of depreciating the value and importance of our most venerable institutions, *and of bringing into contempt those acknowledged authorities which must always meet with the approbation of the best, and the sanction and support of the wisest, portion of mankind* (§ 676, *b*). And I shall here protest against the prevailing fashion of examining and deciding upon the pretensions of every medicinal compound to our confidence, by a mere chemical investigation of its composition, and of rejecting, as fallacious, every medical testimony which may appear contradictory to the results of the Laboratory. There is no subject in science to which the maxim of Cicero *more strictly applies*, than to the present case. *Let the Ultra Chemist, therefore, cherish it in his remembrance, and profit by its application:*

"'NATURÆ VOCE DOCERI, QUAM INGENIO SUO SAPERE.'"—PARIS' *Pharmacologia*, p. 103. *London*, 1825.

And now, for the purpose of showing how any special commentary upon any given substitution for the well-settled method of induction, or for any well-ascertained laws of Nature, is alike applicable to any other fundamental innovation, and how, also, the overthrow of one grand scheme of the day is the immediate parent of another, I shall quote from the *Medical and Physiological Commentaries* a paragraph relative to M. Louis' attempt to foist upon medicine the celebrated

"NUMERICAL METHOD," and ask the reader to apply it to "*Organic Chemistry in its Applications to Physiology;*" and to "*Animal Chemistry applied to Pathology and Therapeutics.*" Thus:

"Thus mounted upon the wreck of philosophy, 'the Numerical Method' ('*Organic Chemistry*') became the engine in rearing that fabric whose construction it was destined to serve. This is the charm with which the Numerical Method (Organic Chemistry) is invested; while it gives to its author that ascendency in mind which few can truly obtain by the legitimate rules of induction. 'After much deliberation,' as Isocrates says, 'he found the thing could not be compassed in any other manner;' or, as our Author has it, 'fortunately for the progress of science, the Numerical Method (Organic Chemistry) is considered by the most judicious and experienced men as *a necessary instrument for establishing general principles in medicine*' (§ 5½ *a*, 349 *d*, 960 *a*, page 719). Accordingly, former systems, and former facts, *fell as* BY ENCHANTMENT (§ 376½, 433). The mind sickened at the absence of all principles to guide it, and was therefore the more willing victim when assailed by the irresistible power of numbers (*symbols*) (§ 960 *a*, p. 719). If the demonstration was made with reiterated professions of *a regard for facts*, it was because the method could have had no existence without them; while the perpetual epithet of '*rigorous*' left no room for skepticism. But, as related, according to Lord Bacon, 'of good Queen Bess, the Commissioners used her like strawberry-wives, that laid two or three great strawberries at the mouth of their pot, and all the rest were little ones. So they made her two or three good prizes of the first particulars, but fell straightways.'"—(*Med. and Phys. Comm.*, vol. ii., p. 782.)

"This manner of digression, however, some dislike, as frivolous and impertinent; yet we are of Beroaldus' opinion,—such digressions do mightily delight and refresh the reader. They are like sauce to *a bad stomach;* and we do therefore most willingly use them."

1006, *b*. The reader will recollect that I had been last speaking of the respect which is due to the experience of the great sages in medical philosophy. I was early led to listen to their conclusions, and to adopt their counsel, as summarily expressed in the foregoing maxim derived from Cicero (§ 1006, *a*). For thirty years I have watched attentively the effects of bloodletting as practiced by myself and by many others, and have long since come to the conclusion, that it is safer to put "the two-edged sword" into the hands of the ignorant, or the imbecile, or those who make a trade of the profession, than to forever blunt its edges, so that it will not cut, before it be trusted to their use. We every where see victim after victim sacrificed to timid admonitions, and worse example; while you, and all of us know, that it is a rare phenomenon that a patient is slain, seldom injured, by the lancet. This is the test, and the strength of it is before the reader.

1006, *c*. On the other hand, is it not too often the case, that eminent and able teachers, who constantly instruct us to pause where bloodletting is indicated, observe a phlegmatic silence as to the injurious tendencies of active internal agents, or urge them upon us as if they were as powerless as water? These, not bloodletting, make up the great abuses of practice. Here, protestations against abuse would come with a benign effect.

Let us at least consider that all other remedial agents of any great importance, even those of the best antiphlogistic nature, are irritants under many circumstances of inflammation, and are, therefore, more or less liable to increase that affection, unless morbid irritability be previously subdued by loss of blood. This is even true of antimonials and ipecacuanha, in irritable states of the alimentary canal. How obvious, then, the importance of often preparing the way for their salutary effects by loss of blood; and, in doing which, we also greatly supersede the necessity of other remedies.

1006, *d*. If we contrast even the scanty cases of injury from uterine hemorrhage, and other accidental losses of blood that may be sustained in health (or try our best at the records of excessive bloodletting, as preserved by the most watchful Brunonian), with the terrible and wide-spread effects of procrastination, or timidity, in the use of the remedy where it has been demanded by disease, and, more than all, with the "bark and wine treatment," we shall have little to fear from the possible abuses of the lancet. A few may be rash from ignorance,—perhaps from the encouragement of others; but will not this encouragement stimulate a host to lay aside their fears, and to moderate their Brunonian practice? Where, then, according to the "numerical method," will be the balance (§ 569, *e*)?

1006, *e*. Where conditions of disease are comparatively mild, their mildness will naturally restrain every practitioner; and when existing in severity, there will be little or nothing to fear from the liberal abstraction of blood, so long as the symptoms resist this principal remedy, and its proper auxiliaries. At most, there can be only now and then a disastrous result; while timid caution has its myriads of victims. Defective judgment there must always be; and it is better, therefore, that it should lean to the side of safety. If going wrong, the error, in respect to *excess* of bloodletting, will be very soon discovered. The timidity of man needs no encouragement, when the question relates to "debility," and "the precious fluid" (§ 569, *e*). But come to cathartics and emetics, nay, tobacco, opium, aconite, belladonna (§ 960, *a*), he is bold and indiscriminate. Here is opened, I again say, an inexhaustible field of inquiry,—far more abstruse and difficult than the management of bloodletting. You may bleed in intestinal inflammation, perhaps to a vast extent, and speedily surmount the disease; when, had an irritating cathartic been exhibited, the scale might have been as speedily turned in the other direction (§ 878).

1006, *f*. Different ages of the world appear to have been distinguished by different degrees of moral firmness, and by remarkable differences in practical habits; and the light of settled experience and of the best philosophy in medicine is almost as apt to suffer a paroxysm of darkness at the advanced as at the earlier stages of science. Certain it is that knowledge had reached a high advance at the time of Hunter, when bloodletting had given a temporary place to the stimulating plan of treatment. Theory and experience governed in one case, hypothesis in the other. No sooner, however, had Mr. Hunter announced the substitution of the stimulant for the depletive treatment, than we hear from Robert Jackson, that "Abstraction of blood in contagious fever, which, but a few years since, was viewed with abhorrence, even branded with the epithet of murder, is *now* considered the main engine of successful treatment" (§ 960, *a*, p. 719).

And, if we look abroad upon the characteristics of the present day, do we not find in animal magnetism, homœopathy, the humoral pathology, the supplications to the laboratory of the chemist for revelations as to the laws and processes of living beings, in health and disease, and many kindred errors and superstitions, a melancholy commentary on the human mind?

1006, *g*. The general treatment of inflammatory and febrile diseases having been well ascertained by Hippocrates and his immediate successors, all departures from their philosophy must be of short duration. It will remain forever a model in the science of medicine, as much as Grecian architecture, and Grecian poetry, will continue to be the true models of taste through all coming time. The reason is, that the philosophy of medicine, like the principles of taste, has its foundation in nature, and that, of all her institutions, medicine is the most intensely interesting. The master-spirits of antiquity observed nature correctly, and drew their conclusions from this only source of correct knowledge. They formed no deductions from the distortions of nature, erected no hypotheses upon the ruins of organization, nor sought in the laboratory of the chemist what can be only found in living beings. Drawing their conclusions from Nature herself, they must remain impregnable against all the adversities of time. The fabrics of philosophy may be mutilated; but the breach will be soon repaired, and the offender will find his proper place in the archives of history. Where the foundation has been substantially laid, the innovations of error are like the momentary peltings of the storm upon the "house that is built upon a rock."

1007, *a*. The general experience of which I have hitherto spoken has been mostly relative to bloodletting in the active conditions of inflammatory and febrile affections. But its advantages are very far from being limited to diseases of a concentrated form, and of rapid progress. They reach, also, and profoundly, the moderated conditions which make up the varieties of chronic inflammation. And here, again, I cannot but entertain the hope that I may have so demonstrated the close similitude of those forms of inflammation which are contradistinguished by the designations of *active* and *passive*, that they will cease, at least, to be regarded as extremes of disease that require exactly opposite modes of treatment; and, therefore, that a better practice may obtain in those chronic cases which have been generally consigned to "bark and wine, and an invigorating diet" (§ 752–756. Also, *Med. and Phys. Comm.*, vol. ii., p. 524–546).

1007, *b*. A few examples will best illustrate and enforce the principle; and to render them emphatic and comprehensive, let us select constitutions broken down by prolonged suffering and wretchedness. An instructive case is recorded by the eminent Kentish. It was the squalid subject of a mortified extremity, which had been advancing to its present state for a year. At this period the leg was removed above the knee. The patient had been crowded for months with tonics and stimulants, and "was reduced to bones." The stump put on an inflammatory action. The admirable surgeon saw nothing but death in prospect, unless he opposed the dictates of philosophy to the prejudices of the lookers-on. "What!" said they, "bleed a poor man who has been confined above a year, and is quite reduced to a skeleton! Oh, shame! shame!" But philosophy triumphed, and ig-

norance stood rebuked. Blood was drawn, and nature began to rally. Still, the system remained oppressed with the effects of former disease, and of former practice. More blood was again and again taken; and at each outlet, nature acquired fresh vigor. The inflammation gave way, and the patient recovered. Near a year afterward Kentish saw his patient, who was then, at sixty years of age, a monument of the benefits of science, and of moral courage (§ $892\frac{4}{5}$ *i*, 998, 1001).

Dr. Borland, a hospital surgeon at St. Domingo in 1796 and 1797, cast away the tonic and stimulant plan which had prevailed, and employed bloodletting and cathartics in the treatment of ulcers. By these means "he often succeeded," says Jackson, "even in persons who were emaciated to the last degrees of emaciation by the continuance of the disease" (§ 992, *a*).

1007, *c*. Here is another case of a parallel nature; only more illustrative of the safety and utility of bloodletting in enfeebled states of the constitution, where disease may demand the remedy in more robust subjects. It is a case of *diabetes*, by Dr. Barlow, in the "Cyclopædia of Practical Medicine." The subject, *a boy*, was reduced by the disease to a feeble and emaciated state. In this condition he was bled to the extent of 209 ounces, or thirteen pounds, within fifty-one days. The operation was repeated twelve times; so that each bleeding of this emaciated boy averaged seventeen ounces. The result of it was, a rapid restoration of health and strength, and a return to his plough (§ 992, *b*).

1007, *d*. Again: "A lady," says Dr. Wardrop, "in a state of pregnancy, had been greatly debilitated," &c. "She was emaciated, and so feeble, that her recovery was, by those around her, considered hopeless. She had a distinct tenderness, on pressure, in the epigastrium, and her pulse, which at first gave the impression of great languor, on more minute examination, was very contracted, feeling like a thread, and incompressible, while the heart's action was vigorous. Bloodletting was immediately resorted to, though with hesitation, by the medical attendants. No sooner had a few ounces of blood flowed from the vein, than the pulse began to rise and acquired volume, and upward of twenty ounces were abstracted before its vigor was subdued." Recovery then went on progressively (§ 997).

1008. The foregoing cases of chronic inflammation (§ 1007), which are common in the walks of the profession, concur in showing that medicine is a science of principles, and that a general treatment is universally applicable to inflammation at all stages of its existence, and under all circumstances. Bloodletting may not always be an appropriate remedy; but a low, or non-stimulant diet, may be the principal antiphlogistic means (§ 752–756, 960, 975 *c*, 1006 *b*).

Of Bloodletting in Infancy and Old Age.

I shall now devote a brief consideration to the applicability of bloodletting to the diseases of infancy and of old age; especially with a view of presenting the experience of a few able practitioners.

1st. *Of Bloodletting in Infancy.*

1009, *a*. We have already seen how the operation of remedial agents, as well as the pathology of disease, is more or less modified

by the physiological peculiarities that are incident to the well-marked stages of life (§ 153–159, 574, &c.).

1009, *b*. These peculiarities are strongly pronounced in infancy; and, when speaking of that period of life, it was seen that diseases are marked by great activity, and by a rapid progress (§ 576). Hence it is obvious that there should be a corresponding promptitude of treatment, and with remedies that make their impression speedily and profoundly. But, it was also said, that nature is now strongly inclined to the restorative process, and that there is great susceptibility to the action of remedial agents. For these reasons, therefore, the same remedies operate with greater effect than at adult age; so that in many cases where general bloodletting would be indispensable at the latter age, leeching may be equally efficient in infancy; or an emetic, or a cathartic, perhaps, may effect what loss of blood could alone achieve in later life (§ 1008).

1009, *c*. But, where bloodletting is demanded by the diseases of infancy, there is no age at which it is better borne, and none at which its early application is so important. It may be also said, in a general sense, that either general or local bleeding is indispensable in all the grave internal inflammations of infantile life; and that the general method should always be practiced in the cerebral inflammations and cerebral congestions of this age, as of all others (§ 974). In similar affections of other organs, leeching is generally preferable in *early* infancy, as indicated under the philosophy of the operation of loss of blood (§ 227 *b*, 925).

1010, *a*. The annals of medicine abound with the best experience in favor of bloodletting in the inflammatory affections of infants.

Sydenham remarks, that, "bloodletting may be as safely performed in young children as in adults, and in some of their diseases there is no curing them without it."

1010, *b*. Rush was an unhesitating advocate of bloodletting in inflammatory diseases at all stages of infancy. "It is more necessary," he says, "in the diseases of infants, than in adults" (§ 1017, *c*).

1010, *c*. Piorry carries bloodletting in the cerebral inflammations and congestions of infants to a great extent,—entirely beyond any thing which I have witnessed; quite as far as quinia in his treatment of indurated spleen (§ 892, *k*). He employs from one to several venesections, and twenty to fifty leeches to the head, with purgatives, &c. This is, doubtless, excessive; but such is the fatality of infantile phrenitis, and such the ability to bear the loss of blood in cerebral inflammation, that the remedy should have no limit short of affording relief (§ 974, 992 *b*). Again, it is the experience of this distinguished observer of the effects of loss of blood, that, "in many young children affected with trachitis, large evacuations of blood have enfeebled them but little;" though "excessive hemorrhage has sometimes produced convulsions." But, I have doubts of Piorry's authority (§ 892, *k*).

1010, *d*. Evanson and Maunsell think, "that in the child, more particularly, bleeding is required in the first stage of all acute inflammations. It may be practiced with safety in the youngest infant, provided we hold in view the relation between the necessities of the case and the strength of the patient." "The buffing of the blood," say they, "is not a safe guide in the child; as we have diseases absolute-

ly requiring bleeding (*e.g.*, croup, bronchitis, &c.), which seldom produce the appearance in question."

1011. It is unnecessary to multiply examples of the foregoing experience. They abound in the archives of medicine. Even at an early era of the art, bloodletting was practiced as fearlessly in infancy, as it was at adult age.

1012. As to my own habits, they have been always uniformly one way. Where inflammation has affected any important organ, or has been otherwise attended with danger, and it seemed not likely to yield at once to milder means, I have taken no risk, but have resorted, without delay, to the *remedium principale;* nor have I ever had occasion to regret a practice which I would so earnestly commend to others (§ 576, *e*).

1013. Finally, it cannot be doubted that Lommius is right in the opinion, that,

"It is much more eligible to snatch a child, by means of bloodletting, from imminent danger of death, however the strength may be wasted, than to let him perish by the violence of the fever."

2d. *Of Bloodletting in Old Age.*

1014. Here, again, as every where else, we find that physiology lends its powerful aid in the treatment of disease, and agrees with the most enlightened experience. Old age is but a summary expression of all the natural obstacles which have accumulated in the way of the organic functions, and which are about to arrest them forever (§ 580–584, 633). The properties of life are now most incapable of sustaining any of the lesions by which they are invaded at earlier ages. They are approaching their natural extinction, and are readily abolished by disease. They are crippled by physical causes of their own production, and have lost much of their susceptibility to the ordinary effects of remedial agents. Changes from a morbid to a healthy condition are slowly determined,—save only by that remedy which makes its powerful, instantaneous, and simultaneous impression upon the main instruments of vital action throughout the body. In every part the properties of life sustain a deep and abiding effect from loss of blood. Their condition is directly and instantly altered in the instruments of disease, and this alteration is maintained by the new sympathetic influences which are determined by other parts (§ 514, *h*), as well as by the continued operation of a diminished volume of blood, and an equalized circulation. The secretions break forth ere we bind up the arm; and thus nature comes to our aid by another efficient process (§ 862, 863). It is all the work of a moment; and the great revolution begun in every part, it may, and often does, terminate speedily in health.

In the formidable diseases of old age, therefore, the remedies must be such as shall reach profoundly the properties and actions of life, and reach them without delay. Such as would be insufficient in youth must surely fail when declining nature is least disposed to co-operate with art.

1015, *a*. The foregoing conclusions are amply corroborated by a large and enlightened experience, which equally demonstrates the groundless nature of the prevailing objections to bloodletting in all the diseases of old age; save only those apoplectic affections in which the

system may be least able to sustain the shock of the operation (§ 990).

In the *Mém. de l'Acad. Roy. de Méd.*, 1840, is a report by M. Prus, setting forth the safety and advantages of bloodletting as practiced extensively in the inflammatory affections of the aged occupants of the two immense establishments, the *Hospice de la Vieillesse*, and *Bicêtre*. He also adds, that, in consequence of the changes which the arteries undergo in aged people, we should always examine the state of the pulse at the heart. "How often," he says, "have patients, whose radial pulse was feeble and irregular, but whose heart announced an energetic action, been bled with the highest advantage, and thus preserved from a speedy and otherwise inevitable death!"

1015, *b*. Such, too, is the experience of Hourman and Déchambre in their treatment of the inflammatory diseases of the old women of *La Salpêtrière;* and M. Piorry bears his testimony, that aged men bore the same abundant bleeding (*des saignées abondantes*) as the old women of Salpêtrière.

1016. Such, then, is enlightened hospital experience, and only a small proportion of such experience. It is manifest, therefore, that if bloodletting be thus admissible and important with the aged inmates of public infirmaries, there is no ground for that distinction which has been set up, in a general sense, between hospital and private patients, and which enjoins the use of tonics and stimulants in one case where it admits of bloodletting in the other (§ 752–756).

1017, *a*. But, since "experientia docet," it may be useful to some to be informed circumstantially of what has happened, in the way of experience, in the private walks of the profession.

Hippocrates, Galen, Celsus, Trallian, and other ancients, advocated bloodletting in the inflammatory diseases of old age. "In bleeding," says Celsus, "the physician should not consider so much the age as the strength of the patient."

1017, *b*. We are told by Wepfer that it is a very prevailing custom among the Swiss, even at eighty and ninety years of age, to resort to bloodletting once a year, or oftener, as a prophylactic.

"I admonish you," says Vitel, "against the advice of those physicians who would dissuade you from bleeding the aged, who may be the subjects of inflammatory or eruptive fevers. The fear of debility is unfounded. Bloodletting is as necessary to them as to the young, and not less beneficial."

F. Hoffmann remarks, "Communis, sed *pessimus error* est, ætatem senilem plane non ferre sanguinis subtractiones, quasi vero in grandævis non redundaret sanguineus latex, ut potius ejus et virium defectu laborarent." "In senili ætate magis necessaria sanguinis missio, quam alia ad morbos grandævis familiares arcendos," etc. "Venæsectio sepius senibus utilissima, imo ad longævam vitam confert.' "Complura certe memoria teneo exempla senum, qui ad nonagesimum annum fere, salvi, incolumes et a morbis ætate provectis familiaribus immunes vixerunt, *solo venæsectionis remedio, bis per annum admisso*." "Id quod etiam a me in *peculiari dissertatione, De Magno Venæ sectionis ad vitam sanam et longam Remedio*, assertum est ac demonstrandum."—*Opera*, t. i., p. 135, 455, 456.

Forestus bled the aged equally without hesitation,—"firmus puer, et robustus senex, tuto curantur."

Van Swieten, the able practitioner and learned commentator, considers bloodletting as important at the extremes of age, as at the intermediate periods.

Finally, all the best writers of the sixteenth and seventeenth centuries advocate bloodletting for the inflammatory and febrile diseases, not only of middle age, but at the extremes of life. They protest, also, against arresting spontaneous hemorrhages, even when occurring at advanced age. The Brunonians have looked on with admiration, when nature has thus rescued the sick from the evils of the bark and wine treatment (§ 980, *e*).

1017, *c.* In later times, the records of medicine continue to abound with demonstrations of the safety and necessity of bloodletting in the inflammations and fevers that may befall old age.

From what was stated of Rush's experience of bloodletting in infancy (§ 1010, *b*), it appears that he considered the remedy most important at the extremes of life; for, in another work, he says, "Experience proves that bloodletting is more necessary, under equal circumstances, in old age, than in any other."—(See my *Examination of Reviews, in Med. and Phys. Comm.*, vol. iii., p. 76–78.)

Hosack deprecates the prejudice which exists against bloodletting in old age.

Sir G. Blane demonstrates the safety and utility of the remedy in the inflammatory diseases of aged people. He states the case of an individual at the age of one hundred years, who was cured of pneumonia by free bloodletting from the arm. In another instance, a lady of eighty-two years, suddenly lost, by spontaneous hemorrhage from the nose, a quart of blood, "which was followed neither by faintness nor weakness, but by improvement in health, in point of vigor and alacrity."

Frank cured an octogenarian of pneumonia by bleeding him nine times. Gui Patin cured his father of pneumonia, at the age of eighty, by bleeding him freely from the arm, eight times. Frèteau bled at the age of seventy, to the extent of four pounds in six days.

And thus might I go on with numerous other coincident authorities; all showing individually, and proving collectively, that old age, *per se*, constitutes no objection to loss of blood. But, were there even hazard in the remedy, its possible dangers would be incomparably less than those of many acute diseases which now so readily destroy. It is no pretext that the patient dies *naturally*, when the chances of life are withheld by the neglect of bloodletting.

Spontaneous Hemorrhage.

1018. I shall now briefly consider nature in her efforts to relieve the system of inflammations and congestions; since it is from the various expedients of Nature that we derive many of our best indications of cure; and the summary mode in which she institutes the hemorrhagic process, and the consequent relief of protracted diseases, are alone conclusive against the Brunonian doctrine of debility, and may encourage the timid practitioner in the use of the lancet (§ 862, 863, 890 *e*, 990 *m*).

1019, *a.* John Hunter has seen several quarts of blood thrown up from the stomach, in a few hours, even by emaciated patients; and recovery has speedily followed the evacuation. Cases of this nature

are witnessed by all practitioners of much experience. The same immense quantities of blood are often discharged from the lungs, and intestine; breaking up the most formidable congestive fevers, and chronic inflammations which have resisted all other means of treatment for years (§ 733 *d*, 890 *e*).

1019, *b*. Lancisi relates the case of a man of seventy years of age, who suddenly lost, in a threatened attack of apoplexy, eleven pounds of blood from his nose, and four more in fifteen days afterward, without any sensible failure of strength.

1019, *c*. Boerhaave "has known almost the entire blood of the body to have been lost by hemorrhage, and yet the subject recover."

1019, *d*. Haller relates many examples of excessive hemorrhage. In one of his cases, one hundred and twenty-five ounces of blood were lost at each menstruation, for several years; besides a daily abstraction of blood from the arm for fourteen months. In another instance, he states that one thousand pounds, or four barrels of blood, were lost in one year, or nearly three pounds daily for that period. In another there was a hemorrhoidal flux of five pounds daily, for sixty-two consecutive days, or a total of three hundred and ten pounds; being probably twice the weight of the whole body. One more lost one hundred and ninety-two ounces, or about thirteen pounds, from his stomach, in a single night, and recovered. Haller, himself, lost one hundred and twenty-eight ounces, or eight pounds of blood, within twenty-four hours.

1019, *e*. Similar examples are constantly presented to our observation, and a large variety may be found assembled in the Medical and Physiological Commentaries. They show us that when Nature takes the work in hand, she does not stop to calculate the ounces, or the pounds, but pushes on till she has accomplished a rational purpose. "Honest Brunonians," says Dr. Beddoes, "have, of late, minutely recorded cases, to them incomprehensible, where immense discharges of blood have suddenly stopped *protracted* fever, and left the patients improved in strength" (§ 890, *e*).

1019, *f*. Among the multitude of these extraordinary hemorrhagic effusions, it is rare that death is an immediate consequence (§ 890, *e*), and rarer still where art has superintended the loss of blood. In the latter case, syncope comes, in good time, to the aid of the patient; far sooner than in the spontaneous process. Nor can art imitate nature in the full extent of her depletory system. The philosophy which respects the difference in effects appears to be this. When the remedy is instituted by nature, the parts concerned in the morbid action are made the instruments of relief, and the general law of adaptation is in force (§ 137 *c*, 733 *d*, 847 *g*). The peculiar modification of action upon which capillary hemorrhage depends, and the influence it exerts upon the system at large, resist the earlier effects of loss of blood when artificially abstracted, and where the same peculiarity of action may not exist. I have seen this principle operating with various effect in inflammations, according as they are modified by remote causes, and according to the activity and extent of disease, the organ or organs affected, &c. (§ 805, 813).

1019, *g*. The more we interrogate nature as to the loss of blood, the more shall we find her proclaiming that this is her expedient, beyond any other by which she attempts the removal of fearful diseases.

Hæmoptysis, hæmatamesis, the hemorrhoidal flux, intestinal hemorrhage, are all instituted for this purpose. We constantly witness the spontaneous effort where the properties of life are so prostrate that art looks on with dread and amazement; and what nature had thus wisely begun is often declared to be the effect of a putrid disruption of the living body, and calls for every counteracting means. Fortunately, these means sometimes consist of the lancet, and other antiphlogistic remedies. But this, with many, is only where the strength is vigorous, and where it is feared that unrestrained nature may possibly reduce it. Examples of this kind are common in pulmonary hemorrhage; and, although in these instances the blood be taken with a view of astringing a suspected rupture of a blood-vessel, the error does not affect the true philosophy of the case; and when nature may be too "sparing of the vital fluid" to overcome the real condition of the lungs, a singular illustration will be obtained of a co-operation of the lancet, toward a salutary result, where it had been employed to defeat the curative effort of nature.

1019, *h*. But error is often committed in these cases. If hemorrhage be profuse, it should be allowed to go on within the limit of safety; since the depletion proceeds from the instruments of disease. A rapid abstraction of blood from the arm, superadded to the hemorrhage, may arrest the spontaneous discharge too speedily; while that which is artificially taken would be more curative if left to the natural process. But, again, where the spontaneous discharge is small, the lancet may be imperatively demanded; while it is here employed with greater caution than in the former cases.

Of misapplied and excessive Bloodletting, "Morbid Irritation," and "excessive Reaction from Loss of Blood."

1020. In the Medical and Physiological Commentaries I have investigated extensively those reputed consequences of loss of blood, which are known as "morbid irritation, and excessive reaction" (vol. i., p. 239–281).

1021. We certainly meet with examples of the foregoing nature, arising from improper bloodletting. But, it is generally too little, not too great a loss of blood, which does the mischief. The untoward results are owing to the unfavorable impression which is thus made upon the organic properties, both by the direct effect of the agent, and by the operation of the nervous influence upon the heart and the main instruments of vital action (§ 965, *b*). The heart, in consequence, beats either with greater frequency or greater force. This is what is denominated "irritation" and "excessive reaction," and is assumed as a proof that too much blood has been abstracted; when, on the contrary, had the loss been carried to a greater extent, these phenomena would have been rarely presented.

1022. And now to show conclusively that the foregoing consequences depend more or less upon imperfect bloodletting, and a consequent aggravation of disease, it will be found, as I have shown extensively in my former Essay on Bloodletting, that in most of the cases recorded by Dr. Marshall Hall and other advocates of the doctrine of "excessive reaction," that the symptoms and post-mortem appearances, as by themselves recorded, denote either the antecedent existence of inflammation and a subsequently exasperated degree, or inflammation

resulting from the loss of blood, or from an antecedent predisposition. The last two causes may act conjointly; and, as I have already shown, too small an abstraction of blood is not an unusual cause of inflammation. Excessive bloodletting, on the other hand, is a rare phenomenon; but, unlike too small a loss, it may establish inflammation independently of any antecedent predisposition.

1023, *a*. When inflammation is induced by excessive loss of blood, the physiological influences are not the same as those which obtain when it ensues upon, or is aggravated by, too small a loss (§ 965 *b*, 1022). In very numerous cases of this nature there has been a pre-existing tendency to the disease; or, more frequently, a morbid condition already established, but not fully developed. Thus, it is not an unusual event, that the physician abstracts blood for pain in the head, or a "stitch in the side," or for some uneasiness of breathing. The abstraction of blood is judiciously moderate. But, there has been an accumulating tendency to inflammation; and the blood thus abstracted proves not to have been commensurate with the demands of the case. It releases and gives force to the general circulation, and increases the irritability of the extreme vessels. Phrenitis, pneumonia, or pleuritis, is the consequence. The physician is alarmed by the unexpected event; yet so like inflammation are the consecutive symptoms, that he ventures upon the lancet for their relief. But, the symptoms had followed upon the loss of blood, and his decision is restrained. He therefore stops at the very point of mischief, and adds another impulse to disease. He may yet bleed again and again, as the malady resists all other agents; but the same caution prevails, and the evil increases at every partial outlet of blood.

These cases accumulate rapidly upon the hands of the unskillful or timid. Records are examined, and parallel examples are found to abound. Dissections are made, and reveal the usual physical signs of inflammation. The conclusion, therefore, comes up, as expressed by Dr. Hall, that there is a disease "exactly like inflammation, but totally different from it"!

Just so it is with child-bed women. There is often a great tendency, in these cases, to local inflammations; and these may be more or less speedily developed by moderate flooding, especially if there have been previous venous congestion, as is very frequently the case (§ 803, 965 *b*). Dr. Hall has many of these examples, and were they really cases of simple irritation, or simple exhaustion and excessive reaction from loss of blood, they could not be adduced to illustrate the effects of bloodletting in disease. They should form a class by themselves; designated as cases of the morbific effects of "excessive loss of blood" upon the comparatively healthy system. They must, therefore, be admitted to have no bearing upon cases where bloodletting may have been demanded, and to be worse than useless for illustrating the effects of bloodletting as a remedy. As well might one say, that cathartics shall not be given in disease, or only so with fear and trembling, because they may be pernicious in health. And he, being well, who should physic himself in order to be better, would be mad indeed, should he attempt to remove the evils of his mistake by swallowing one dose after another. Just so it is in respect to bloodletting, or accidental hemorrhage, in health. If inflammation follow in the latter instance, it will be important to ascertain whether excessive

bloodletting have been the exciting cause, or whether it did not spring from a previous disposition to disease; since the treatment will be entirely different in the two cases. The former case is rare, as known from the accidental and profuse hemorrhages that are daily occurring. Nor is even simple irritation a common result; the injury consisting mainly in feebleness. And here I may say, that it is a remarkable fact, that the effects described by Dr. Hall as incident to lying-in women rarely supervene upon excessive flooding; thus showing that in the cases of disease the affection existed already, or was about taking place.

1023, *b*. When, however, inflammation is actually induced by excessive loss of blood, the effects of the physiological influences are different from those which I have set forth as constituting the philosophy of the operation of loss of blood. The effects are morbific in one case, but are not so, or are curative, in others. The *modus operandi*, however, is exactly the same in all the cases; and, being so, the morbific effect confirms my philosophy of the modus opérandi of the curative influences. In the former case, an injury is inflicted, suddenly, and severely, upon the *vires vitæ* of all parts, and the nervous influence is powerfully determined upon all. The brain suffers the impression particularly; and if "irritation," or "excessive reaction," follow, I know of no recorded instance which has not also presented the usual phenomena of inflammation, either in the brain or some other organ. If death ensue, effusions of serum, or of lymph, or disorganization, &c., are the concurring results. Still, however, another cause, and not the loss of blood, may have produced the disease, and have been overlooked.

1024, *a*. Dr. Hall, who, particularly, called our attention to the foregoing "irritation," and "excessive reaction," as frequent effects of excessive loss of blood, and distinguishes those conditions from inflammation, concedes that "exhaustion from loss of blood is not only not incompatible with repletion and a tendency to effusion within the head, but it actually supposes that condition of the encephalon, when long protracted." He also states that leeches to the head are one of the remedies. So, too, will general bloodletting relieve the symptoms, but perhaps only temporarily; since, when inflammation is aggravated or induced by an excessive loss of blood, such is the combined nature of the exciting cause and its curative effects, the modified irritability of the vessels may readily yield, at the moment, to a farther loss, but may soon obey the original principle.

1024, *b*. In my remarks upon the physiological effects of bloodletting, I endeavored to show that, when the loss of blood is carried to a state of syncope, and more especially to any injurious excess, the greatest severity of its influence is sustained by the brain (§ 950). It is to the head, then, that we should generally look for the local injury, if any attend the reputed cases of irritation and exhaustion from an excessive loss of blood. This is precisely what we find stated by the late writers who have treated of this subject; at least in a general sense.

1024, *c*. But, as the question under consideration is of no little practical importance, it may be well to have before us Dr. Hall's highly-descriptive account of the severe grades of what he calls "exhaustion with excessive reaction," and as supplying the most ample proof that

the supposed condition is, in reality, a state of active inflammation. Thus:

"The beating of the temples," says Dr. Hall, "is at length accompanied by a throbbing pain of the head, and the energies and sensibilities of the brain are morbidly augmented; sometimes there is intolerance of light, but still more frequently intolerance of noise and of disturbance of any kind, requiring stillness to be strictly enjoined, the knockers to be tied, and straw to be strewed along the pavement; the sleep is agitated by fearful dreams, and the patient is liable to awake or to be awoke in a state of great hurry of mind, sometimes almost approaching to delirium; occasionally even continued delirium; more frequently there are great noises in the head, as of singing, of crackers, of a storm, or a cataract; in some instances there are flashes of light; sometimes there is a sense of great pressure or tightness in one part or round the head, as if the skull were pressed by an iron nail, or bound by an iron hoop."

1024, *d*. Now, the foregoing symptoms, which Dr. Hall considers as denoting a state exactly *opposite* to that of inflammation, when they attend considerable losses of blood, are precisely such as are characteristic of cerebral inflammation when induced by other causes. But, as if to remove all doubt as to this conclusion, this distinguished philosopher reiterates the foregoing account, and designates other phenomena not less significant of cerebral inflammation, such as "frequent delirium," "hardness of pulse," "buffy blood," &c.; and, to give to the subject its utmost force, he calls to his aid the opinions of Cook, Coke, Kellie, Tweedie, Hammond, Cox, and others; all of whom agree in testifying to the symptoms that mark, exactly, the character of inflammation of the brain. Nay, more, he allows this conclusion,—that they are "attacks which resemble inflammation of the head, chest, or abdomen, and yet are *totally different* in their nature."

And then, as to our author's excellent description of the general phenomena, which he imputes to this disease that is considered so opposite to inflammation, they are, to my mind, conclusive against our author's doctrine.

1024, *e*. Morbid anatomy contributes, also, its corresponding proof. "The next point for our consideration, in the inquiry into the morbid effects of loss of blood," says Dr. Hall, "will be that of the organic changes induced during the state of sinking. These are chiefly observed in the brain, in the cavities of the serous membranes, in the bronchia, in the lungs, and in the track of the alimentary canal, under the forms of *effusion*, *œdema*, and tympanitis." At other times, our author admits of *morbid redness*, and absolute *disorganization*, as rapid consequences of this affection, so opposite to inflammation.

1024, *f*. Such, indeed, is the entire coincidence between our author's supposed cases and those of inflammation, that we are told by the author that there is often no other test of their distinction than the treatment which is adapted to inflammation. We must bleed; and if the patient bear it well,—*well*;—if otherwise, we must then endeavor to repair the wrong. This after-knowledge, this dependence for the diagnosis upon the effects of treatment, may help the understanding; but will it be likely to help the patient, or to improve the science? And how is the treatment improved by this species of intelligence? The greatest zealot would abandon the diagnostic test,

if he found it injurious. But, says Dr. Hall, the patient "may be greatly relieved by the loss of blood;" "the temporary relief which follows general bloodletting may be so uniform as to impose on the inexperienced." Then I maintain that the loss is useful.

1024, *g*. In the foregoing cases, as related by Dr. Hall, and others, where there had been bloodletting, we may generally recognize the occurrence of cerebral inflammation independently of the loss of blood, and often of its pre-existence; and I as sincerely believe that farther bloodletting was the proper remedy for the disease. In the cases where irritation, and excessive reaction, are said to have been consequent on spontaneous hemorrhage, it is not less apparent that, in most instances, inflammation had already existed, or there was a strong predisposition to it.

1025. There are few practitioners in the United States who have seen more of bloodletting than myself; and I am therefore quite conversant with cases of the foregoing nature, as I have met with them in the hands of others. In numerous instances where the attending physician had imagined "excessive reaction, and prostration from excessive loss of blood," I could discover nothing but the onward march of inflammation, that called for greater abstractions of blood; and that this opinion was right has been generally confirmed on resuming the depletive treatment.

1026. Finally, as I have said in the "Commentaries," the rules for bloodletting which have been propounded by Dr. Hall, and all others of a like nature, are captivating by their simplicity. This was the secret of the popularity of Brown's Elements of Medicine, and of the long, unmolested sway of the Humoral Pathology. A later and more universal example is seen in the chemical views of life and disease.

Many have imbibed an erroneous impression that Dr. Hall is a warm advocate for the use of the lancet; and, as the case of Dr. Hall is very extensively applicable to physicians, I shall state the nature of the misapprehension. Dr. Hall advocates bloodletting only in certain affections where few would deny the propriety of the remedy; and in such cases he commends its liberal use. But, what he has so far said with emphasis has the effect of discouraging its application in the vast class of congestive fevers, and depressing inflammations, and even in many of the cases to which, on general principles, he admits its applicability.

But it is not alone by his exclusive precepts that his purpose is attempted. On more than one occasion, he broadly affirms, that "it is difficult to say whether more injury has been done by an undue, or by an inefficient, use of the lancet." Such is the balance which is often struck by apparent advocates of bloodletting; but, I am still apt to think, with Botalli, that "One hundred thousand men perish from the want of bloodletting, or from its not being timely employed, where one perishes from excessive bleeding, when prescribed by a physician."

General Conclusions as to Bloodletting.

1027. From all that has been now said on the subject of bloodletting, I arrive at the following general conclusions:

1. That loss of blood produces its direct and efficient impression upon the *vires vitæ* of the capillary blood-vessels, by modifying their action.

2. That the quantity of blood to be abstracted relates directly to the foregoing impression.

3. That the most salutary effect of loss of blood will, therefore, consist in its nearest approximation to a full but just impression upon the *vires vitæ*.

4. That, to produce and maintain the foregoing impression, will require the abstraction of a certain quantity of blood in every case, the measure of which will be the antecedent and resulting symptoms.

5. That bloodletting may add to the force of disease by coming short of that impression; or, it will be injurious if carried to excess, or may even induce new inflammations.

6. That the local, and sometimes the general, abstraction of blood may be remedial when inflammation is induced by excessive bloodletting alone.

7. That bloodletting may be a remedy for other diseases than inflammation and fever.

8. That loss of blood is equally safe at all periods of life, is most indispensable, in a general sense, in old age, though not less important in many diseases of infancy.

9. That, when employed as a prophylactic, on passing from northern to tropical countries, it must be with such moderation as shall not increase irritability; and then only in the plethoric and robust.

10. That general bloodletting, cupping, and leeching, operate upon common principles, which are more or less modified in each mode of abstracting blood. That cupping is intermediate, in this respect, between general bloodletting and leeching.

11. That general bloodletting is a far more important remedy than leeching; and that, while cases constantly arise in which the latter cannot be substituted for the former, there are numerous instances in which general bloodletting cannot take the place of leeching. That cupping will sometimes answer the purposes of either, and may be, though rarely, better.

12. That the brain has a peculiar allotment in the effects of loss of blood; and that inflammation of this organ will generally sustain a greater loss than any other. That there are, however, peculiar conditions of the brain, as in some cases of mania, the delirium of drunkenness, and especially apoplexy, in which, on account of the relation of the nervous influence to the organic powers, and the manner in which that influence is determined by loss of blood, its abstraction may be either inadmissible, or must be practiced with great circumspection.

13. That spontaneous hemorrhage, occurring at adult age, should not be restrained, unless manifestly proceeding to excess.

> "Truth, like a single point, escapes the sight,
> And claims attention to perceive it right;
> But what resembles truth is soon descried,
> Spreads like a surface, and expanded wide."—POMFRET.

INDEX.

A.

ABSORBENTS,

consist of the lacteals and lymphatics; one for formative, the other for destructive purposes, p. 129, § 273. See, also, VEINS, TISSUES, and ABSORPTION.

ABSORPTION,

description of the function, &c., p. 128–134, § 268–295.

comparative view of its physical philosophy with that of digestion, animal heat, bloodletting, humoralism, inflammation, &c., p. 99, § 192; p. 132, 133, § 289–292; p. 197, § 362; p. 238, § 438 *b–d*; p. 457, § 699 *c*; p. 482, § 744; p. 484, § 748; p. 518, § 823; p. 550, § 863 *e*; p. 690, § 906 *a*; p. 691, § 909, 910.

of unnatural agents, depends upon morbid changes in irritability, p. 99, § 192; p. 129–134, § 277–295; p. 519–521, § 826–827.

operates universally through the lymphatics, and without the aid of any specific stimulus, p. 46, § 74 *a*, but requires a specific stimulus in the lacteals. See NUTRITION.

ACONITE, ATROPIA, STRYCHNIA, HYDROCYANIC ACID, CARBONIC ACID GAS, NITROUS OXIDE GAS, SULPHURIC ETHER, TOBACCO, &c.

their effects upon organic life, and mode of operation, p. 66, 67, § 143, 148–151; p. 318–321, § 493 *d*–494; p. 415–418, § 648 *c*–652 *c*; p. 420, § 654 *a*; p. 522–525, § 827 *b*–828 *c*; p. 672–674, § 904 *b*.

ADAPTATION, LAW OF,

propounded by the author in a series of propositions, p. 45, § 73 *a*; p. 46, § 74 *a*; p. 58, 59, § 129; p. 61–63, § 136–137; p. 65, 66, § 143; p. 67, 68, § 149–152; p. 69, § 156 *b*, and *references* there; p. 89, § 188 *a*; p. 90, § 188½ *a–c*; p. 93–95, § 188½ *d*; p. 98, § 191 *a*, *b*; p. 99, § 192; p. 101, 102, § 201–203; p. 107, § 226; p. 110, 111, § 233–233¾; p. 330, 331, § 500 *n*, *o*; p. 350–361, § 524–529; p. 430–433, § 675; p. 531, § 837 *cc*–839; p. 535–539, § 847–849; p. 542, § 843 *c*, *d*; p. 545, § 859 *b*; p. 553, § 870 *aa*; p. 555, § 872 *a*; p. 561, 562, § 888 *a–d*; p. 565, 566, § 889 *g–k*; p. 570, § 889 *n*; p. 580, 581, § 890½ *e*; p. 582–585, § 890½–591 *e*; p. 586–588,

Adaptation, Law of—*continued.*

§ 891 *g–l*; p. 592, 593, § 891½ *k*; p. 597, § 892 *c*; p. 601, § 892 *g*; p. 605, § 892 *m–p*; p. 607, § 892 *r*; p. 613, § 892¼ *b*, *c*; p. 624, § 892⅔ *d*; p. 629, § 892⅔ *s*; p. 632, § 892¾ *c*; p. 633–642, § 892⅘ *a–i*; p. 644–650, § 893 *c–i*; p. 658–660, § 893 *p–r*; p. 662–664, § 895–899; p. 669, § 902 *h*, *i*; p. 670, § 902 *m*; p. 679–683, § 905; p. 684–688, § 905½ *b*, *c*; p. 692–694, § 914–923 *b*; p. 698–709, § 929–951.

ADHESION. See INFLAMMATION.

ADULT AGE,

its physiological and moral character istics, p. 380–381, § 579.

AFFINITY, VITAL. See VITAL AFFINITY.

AGE,

its physiological and moral characteristics, p. 373–383, § 574–584.

ALIMENTARY CANAL,

experiments to determine the Principle upon which its Action depends, p. 315.

ALLOTROPISM,

applied to illustrate the philosophy of life, p. 99, § 191 *d*.

ALOES. See CATHARTICS, THERAPEUTICS, VITAL HABIT, and REMEDIAL ACTION.

ALVINE DISCHARGES,

in their relation to disease, p. 452–455, § 694, 694½.

ALKALOIDS OF CINCHONA,

their therapeutical uses, p. 593–607.

ALTERATIVES,

all things such, moral and physical, which are capable of changing the existing condition of the vital states, p. 542, § 854 *c*; p. 662–665, § 895–901.

in large doses or degrees their remedial or morbific effects may be speedy and profound; in small and frequently-repeated doses or degrees, the same effects may be only gradually established, in conformity with the fundamental plan of organic nature, p. 89, 90, § 188–188½ *b*; p. 107–110, § 226–232; p. 122, § 240; p. 210, § 387; p. 214–217, § 393–399; p. 222–227, § 409 *c*–411; p. 230–232, § 421–424; p. 250, 251, § 441 *c*; p. 260–265, § 445–447 *b*; p. 272, 273, § 447 *h*; p. 280, § 449 *d*; p. 283–287, § 452–458; p. 290, § 462, 463; p. 295, § 476 *a*; p. 323–332, § 498 *f*–500; p.

Alteratives—*continued.*
335–341, § 512–514; **P. 344, 345, § 516** *d*, No. 6; p. 364–369, § 546–564; p. 423, § 659, 660; p. 426, § 666; p. 428, § 672; p. 541, § 854 *a, b;* p. 542, § 854 *c–e;* p. 544, § 857; p. 545, § 859 *b;* p. 547, § 863 *d;* p. 547–550, § 863 *b–e;* p. 552, § 867; p. 554, § 871; p. 556, 557, § 873; p. 562, § 888 *e;* p. 567–569, § 889 *l–mm;* p. 577, § 890 *o;* p. 579; p. 598–600, § 892 *d;* p. 662–665, § 895–901; p. 666–670, § 902 *c–m;* p. 679–681, § 905; p. 703–711, § 940–952; p. 724, § 961 *a;* p. 726, § 961 *c–e;* p. 732, 733, § 973–974.

AMENORRHŒA. See EMMENAGOGUES, UTERINE AGENTS, and ERGOT.

ANALOGIES,
between Animals and Plants. See PLANTS.
between semen and all other vital agents, p. 44–49, § 72–80; p. 84, § 175 *b;* p. 331, § 500 *o.*
between the nervous power and all other vital agents, p. 107–111, § 226–233¾; p. 662, 663, § 896. See, also, NERVOUS POWER.
between Vital Principle and Mind and Instinct, p. 84, § 175 *b;* p. 88, § 183, 184; p. 89, § 186; p. 98, § 191 *c;* p. 112–125, § 234–246; p. 370, § 567, 568.
between Vital Properties, p. 97–99, § 190–191; p. 100, § 197–200; p. 102, § 203; p. 104, § 215; p. 105, § 220; p. 107–110, § 225–232; p. 112, § 234 *b.*
remote, but illustrative, between the Vital Principle and the "Imponderables," p. 92–95, § 188½ *d;* p. 112–122, § 234–238.
between all Physical and Moral Causes, in their relation to Life, p. 44–49, § 72–80; p. 62–68, § 136–152; p. 84, § 157 *b, c;* p. 92–95, § 188½ *d;* p. 96, § 189 *c;* p. 97, § 190; p. 104, § 215; p. 107–111, § 225–233¾; p. 113–122, § 234–240; p. 250, 251, § 441 *c;* p. 296, § 476 *c;* p. 323–332, § 500; p. 356–358, § 526 *d;* p. 363–370, § 535–568; p. 405–412, § 638; p. 543, § 857; p. 577, § 890 *o;* p. 579, 580, § 890½ *d;* p. 597, § 892 *c;* p. 631, § 892¾; p. 645–647, § 893 *c, d;* p. 662–665, § 895–901; p. 669, § 902 *h;* p. 670, § 902 *m;* p. 679–683, § 905; 692–694, § 914–923 *b;* p. 698–709, § 929–951. See, also, REMEDIAL ACTION and VITAL AGENTS.

ANALOGIES, FALSE,
productive of error, p. 10, § 5½ *a;* p. 43, § 67; p. 84, § 175 *c;* p. 90–95, § 188 *d;* p. 132, 133, § 289–292; p. 157–173, § 350; p. 182, § 350¾ *g;*

Analogies, False—*continued.*
p. 238–245, § 438 *b*–440 *e;* p. 518, 519, § 823, 824.

ANALOGY,
the great basis of science, p. 12, § 5¼ *f;* p. 183, § 350 *gg.*

ANALYSIS, CHEMICAL,
its limits, p. 14, § 6; p. 15, § 14 *b;* p. 16, § 15; p. 18, § 18 *d;* p. 24, § 42; p. 25, § 44; p. 27–29, § 53, 54; p. 221, 222, § 409 *b;* p. 228, § 417 *a.*

ANASTOMOSIS,
its uses, p.53, § 94; p. 54, 55, § 109–117.

ANATOMY,
uses of, p. 3, § 2; p. 50–73, § 83–163.
the basis of medicine, p. 3, § 2 *c;* p. 50–73, § 83–163.
teaches nothing, *per se*, in physiology, pathology, or therapeutics, p. 3, § 2 *c;* p. 50, § 83 *c;* p. 59, 60, § 131.

ANATOMY, MORBID,
its uses, &c., p. 456–463.

ANIMALCULA,
their uses, p. 15, § 14 *b.*

ANIMALS, FOOD OF,
of an organic nature, p. 16, § 17; p. 17–20, § 18.
can not be indicated by chemical analysis, p. 17–20, § 18; p. 219–222, § 409; p. 235, § 433. See, also, PLANTS.

ANIMAL FUNCTIONS, p. 280–362, § 450–534.
consist of *Sensation, Sympathy, Voluntary Motion,* and the *mental* and *instinctive*, p. 125, § 250.

ANIMAL HEAT,
organic, and chemical, philosophy of, p. 234–279, § 433–448.
chemical basis of, p. 238, § 438 *b–d;* p. 276, 277, § 447½ *f.*
organic basis of, p. 271, § 447 *f;* p. 273, § 447 *h;* p. 662, 663, § 896. See, also, COMBUSTION.

ANIMAL KINGDOM,
dependent on the inorganic, p. 15, § 9; p. 16, § 14 *c;* p. 23, § 35, 37; p. 24, § 41, 42; p. 25, § 43; p. 135–138, § 300–303¼.
dependent on the vegetable kingdom, p. 15, § 10, 13, 14; p. 16, § 17; p. 135–139, § 300–303½.
its peculiar properties, p. 88, § 184; p. 106, § 223. See, also, SENSIBILITY, and NERVOUS POWER, and SENSATION and SYMPATHY, and PLANTS.

ANIMAL LIFE,
founded upon organic life, p. 53, § 98–103; p. 54, § 108, 110, 111; p. 55, § 114–117; p. 143–146, § 322–326. See, also, LIFE, and ORGANIC LIFE.

ANIMAL MAGNETISM,
who its advocates are, p. 77, § 167 *f.* p. 187, § 350¾ *kk;* p. 534, § 844; and BRITISH AND FOREIGN MEDICAL RE-

Animal Magnetism—*continued.*
VIEW, *Oct.*, 1846, p. 475–487. Also, *ibid.*, p. 428–458, or *Medicine Relapsing into the Dark Ages.*
its deceptive nature, p. 77, § 167 *f*, *note.*
how it may sometimes operate, p. 534, § 844.
hearing, seeing, tasting, one or all, show that perception is awake, and that the skin, nerves, &c., equally feel when cut, pricked, &c., or when teeth are extracted; while connected speech evinces the full operation of the will, judgment, reflection, perception, memory, the understanding. That is a test, as are, also, the established laws in Physiology, p. 77, *note.* Consult, likewise, the physiological law as pronounced in the harmonious and progressive development of all the senses in infancy, and SOMNAMBULISM, and REASON.
firmness of purpose and mental excitement will enable most people, especially in health, to endure suffering without complaint. The former operates through the will alone, and does not diminish or prevent suffering; the latter by subduing *common* sensibility, and thus removing and even preventing pain, as seen in subsidence of toothache at the approach of the dentist, and in the subsequent little suffering incident to the operation of extraction, p. 77, *note;* p. 124, § 243; p. 534, § 844; p. 588, 589, § 891 *m.* See, also, SENSIBILITY, SENSATION, and the NERVOUS POWER.

ANIMALS AND PLANTS,
their fundamental distinction, p. 15, § 11; p. 17–20, § 18; p. 135–139, § 303–303½. See, also, PLANTS.
their Composition, p. 15, § 12. See COMPOSITION.

ANTIMONY, TARTARIZED. See THERAPEUTICS, REMEDIAL ACTION, VITAL HABIT, SUDORIFICS, EMETICS, and EXPECTORANTS.

ANTISPASMODICS, p. 590–593.

APPROPRIATION, OR NUTRITION AND SECRETION,
laws of, p. 217–227.

ARGUMENTATIVE DISCUSSION,
some common ground necessary to, p. 401, § 632 *b.* See, also, ORGANIC CHEMISTRY, ITS RECOMMENDATIONS.

ARSENIC, p. 607–612. See, also, INFLAMMATION.

ARTERIES,
experiments to determine the Principle upon which the Action of the Heart and Arteries depends, p. 295–301. See HEART AND ARTERIES.
experiments relative to the Arteries in their connection with the Nervous System, p. 305–310.

ARTERIAL TISSUE. See TISSUES, and STRUCTURE.

ASSIMILATION, p. 134–207.

ASAFŒTIDA. See ANTISPASMODICS, and EXPECTORANTS.

ASTRINGENTS, p. 570–578.

ATHEISM,
author's refutation of, p. 16, § 14 *c.* See, also, DESIGN.

ATMOSPHERE,
primary source of nourishment to plants, p. 135–139, § 303–303½.
proves their creation before animals, p. 136–138, § 303–303½ *b, c.* See, also, NITROGEN, ANIMAL KINGDOM, ANIMALS and PLANTS, and COMPOSITION.

ATMOSPHERIC AIR,
necessary to all organic beings, p. 21, § 20.

ATTRACTION, CAPILLARY,
as applied to organic beings. See ABSORPTION, and CAPILLARY ACTION.

AUTHORS,
their opinions, not themselves, the subjects of criticism, p. 6, § 4 *b;* p. 154, 155, § 349 *d;* p. 515, § 819 *b;* p. 540, § 851 *c.*
indicated as sources of authority, *ibid.*
their fallacious statements may form their best refutation, and yield the greatest light to truth, p. 17–19, § 18; p. 38–40, § 64 *f–h;* p. 84–86, § 175 *c;* p. 96, § 189 *b;* p. 132, 133, § 289; p. 135–139, § 303–303¾; p. 157–191, § 350, 351; p. 199–202, § 364–376; p. 220–222, § 409 *b;* p. 234–279, *passim;* p. 433, 434, § 676 *b;* p. 514, 515, § 819.
Erratum, p. 155, line 19 from top, for *their* read *this.*

B.

BALSAMS, EXPECTORANT,
when useful. See EXPECTORANTS.

BELLADONNA. See NARCOTICS, and ACONITE.

BILE,
its mode of production, p. 181, § 350¾ *e.*

BLISTERS. See COUNTER-IRRITANTS, and REMEDIAL ACTION.

BLOOD,
AUTHOR'S theory of the powers by which it is circulated, p. 208–217.
chemical views of, p. 18, § 18.
organic elaborations from, each one specific, p. 18, § 18 *d;* p. 24–34, § 40–62; p. 192, § 354; p. 216, § 398;

Blood—*continued.*
p. 222, § 409 *c;* p. 225, § 409 *h, i;* p. 227, § 411.
homogeneous, p. 24, § 42, *note;* p. 25, § 43.
composed of seventeen elements, p. 24, § 42; p. 25, § 43; p. 225, § 409.
rapidity of its chemical changes, p. 29, § 54 *a.*
rapidity of its organic changes, p. 233, § 427; p. 535, § 846; p. 537, § 847 *c;* p. 710, 711, § 952.
decarbonization of, a vital function, p. 229, 230, § 419, 420; p. 274–278, § 447½.
not medicated by unaided Nature, p. 531, § 839.
chemical theory of its Circulation, p. 157, 158, 159, § 350, Nos. 3, 7, 8, 9; p. 208, 209, § 383 *a, b;* p. 329, § 500 *n.*
globules of, the "*carriers of oxygen,*" p. 255, § 441 *f;* p. 256, § 441½ *d;* p. 275–278, § 447½ *b, f.*

Blood, Loss of,
its Modus Operandi, and Application to Disease, p. 690–777.
relation of the Nervous Power to its Effects, p. 703–711.
morbid Irritation, and Excessive Reaction from, p. 772–776.

Bloodletting,
according to tissues affected, p. 72, 73, § 162.
Author's theory of its *modus operandi,* how far original, p. 691, § 906 *g.*

Bloodletting, General, p. 698–702.
general and Practical Observations upon, p. 711–777.
general Extent of, p. 711–724.
in Congestive Forms of Disease, p. 724–732.
in the Recognized Forms of Inflammation, p. 732–736.
in Simple Continued and Simple Intermittent Fever, p. 736–741.
in the Cold Stage of Fever, p. 739–741.
in Apoplexy, p. 741–747.
general Experience, and Opinions respecting, &c., p. 747–766.
in the Diseases of Infancy, p. 766–768.
in the Diseases of Old Age, p. 768–770.
misapplied, Excessive, &c., p. 772–776.
general Conclusions as to Loss of Blood, p. 776–777.

Blood-Root. See Expectorants, and Therapeutics.

Blood-vessels,
their essential office, p. 43, § 68–71; p. 54, § 109 *b;* p. 208–217, § 382–399; p. 219, § 407, 408; p. 223–227, § 409 *e*–411; p. 289, § 461½ *a.*
their supposed chemical relations, p. 43, § 67; p. 178–181, § 350¾; p. 226, § 409 *j.*
the white, admit the red globules through

Blood-vessels—*continued.*
morbid changes of irritability, p. 99, § 192.

Blood-vessels, capillary. See Capillaries, and Heart and Arteries.

Blue Pill. See Cathartics, Alteratives, Therapeutics, and Remedial Action.

Brain,
or its equivalent, the *Ganglionic System,* in the lower animals. See Nervous Power, and Cerebro-Spinal System.
co-operates with the Mind, or with the Instinctive Principle, p. 123, § 241 *c.*
and spinal cord, not necessary to fœtal life, as seen in the anencephalus; and possibly the sympathetic, though this is probably indispensable to the function of the sphincter muscles, p. 128, § 264; p. 289, § 461½ *a.*

Bromine. See Iodine, and Alteratives.

C.

Calomel. See Cathartics, Therapeutics, Vital Habit, Remedial Action, and Alteratives.

Caloric. See Calorification.
an unexplained phenomenon of, p. 276–278, § 447½ *f.*

Calorification,
its philosophy investigated, p. 234–279, § 433–448. See Heat of Animals and Plants, and Combustion.

Camphor. See Antispasmodics.

Cantharides. See Counter-irritants.

Capillaries and Extreme Vessels,
the former reservoirs to the latter, p. 216, § 398; p. 483, § 746 *a.*
the latter, the main instruments of life and disease, p. 42, § 67; p. 54, § 109; p. 215–217, § 394–399; p. 218, § 404; p. 219, § 407 *b;* p. 226, § 410; p. 227, § 411; p. 286, § 456 *a;* p. 289, § 461; p. 322, § 498 *c;* p. 479, § 741 *b;* p. 483, § 746 *a;* p. 485, § 750 *a.* See, also, Heart and Arteries.

Capillary Action,
physical views of, subversive of all principles in Physiology and Medicine, p. 215, § 394; p. 216, § 398; p. 219, § 407 *b;* p. 226, 227, § 410, 411; p. 483, § 746 *a;* p. 485, § 750 *a.*
that its nature is strictly vital is shown by direct experiment, p. 127, § 263; p. 134, § 293; p. 216, 217, § 399; p. 289, § 461½ *a;* p. 295–310, § 476–485;—is shown by the composition of the blood and sap, p. 23, § 34, 35;—is shown by the variety and exactness of secreted products, and other phenomena, p. 23, § 37; p. 24, 25, § 41–46; p. 40, 41, § 65; p. 44, §

Capillary Action—*continued.*
72; p. 222–227, § 409–411; p. 479, § 741 *b;* p. 663, § 896;—and is shown by the light of analogy as reflected from all sensible motions in organic and animal life. See Capillaries, Plants, Analogies, Nervous Power, and Sympathy. See, also, Absorption, Blood-vessels, Powers which Circulate the Blood, and Experiments to determine the Laws of the Vital Functions, and Remedial Action.

Capillary Attraction. See Capillary Action, &c.

Carbon,
- its elimination from the blood, a vital function, p. 236, 237, § 437. See, also, Mucous Tissue.
- theory of its combustion in the animal organism, as it respects the generation of heat, p. 235, § 434, 435; p. 238–248, § 438–440; p. 275–298, § 447 *c*–447½.
- theory of its combustion in producing the circulation of the blood, p. 157, 158, 159, § 350, Nos. 3, 7, 8, 9; p. 208, 209, § 383; p. 329, § 500 *n.*
- theory of its combustion in producing inflammation, p. 160, § 350, No. 10; p. 176, 177, § 350¾ *a*, 350¾ *e;* p. 252, § 441, *c.*

Carbonic Acid,
- a food of plants, p. 136–139, § 303 *a*–303¾.
- agency of light in its decomposition, p. 93, § 188½ *d;* p. 163–167, § 350, Nos. 64–77.
- its connection with respiration, p. 229, § 418, 419; p. 274–278, § 447½.
- its supposed connection with animal heat. See Calorification.

Castor Oil. See Cathartics, and Therapeutics.

Catalysis,
- applied to organic processes, p. 43, § 67; p. 178–181, § 350¾ *a*–350¾ *e;* p. 226, § 409 *j.*
- conflict between, and the *moving molecule*, or the rival doctrines of the Laboratory, p. 226, § 409 *j.* See, also, Protein.

Catechu. See Astringents.

Cathartics, p. 563–570.
- physiology of their operation and influences, p. 339, § 514 *f;* p. 547–550, § 863 *d;* p. 563–570, § 889. See, also, Remedial Action.
- most appropriate time for their administration, p. 554, § 871; p. 570, § 889 *n;* but the same rule does not apply equally to emetics, p. 549, 550, § 863 *d.*

Causes,
- their knowledge important, p. 4, § 3, 4; p. 80, § 169 *d;* p. 120, § 235, 236; p. 434, 435, § 679, 680.
- to be sought through their phenomena, p. 10, 11, § 5½; p. 80, § 169; p. 112–121, § 234 *c*–237; p. 182, § 350¾ *g;* p. 434, § 679; p. 456, 457, § 699.
- undervalued by the ignorant alone, p. 5, § 4 *b.*

Causes, Proximate or Pathological, p. 427–434.

Causes, Remote, of Disease, p. 414–427.

Causes, Final,
- have led to important discoveries in medicine and astronomy. See Design.

Cells,
- characteristic of organic structure, p. 51, § 84.
- supposed nucleus of, in ovum, p. 42, § 67; p. 60, § 131.

Cerebro-Spinal System,
- *its Laws of Action*, p. 292–295.
- *general Facts and Laws relative to, and to the Ganglionic*, p. 335–341.
- pervades all parts, p. 54, § 111–113.
- important to complex organization, p. 54, § 111–113; p. 58, § 129.
- designed especially for Animal life, p. 55, § 112. See Nervous Power, and Sympathy.

Chemical Physiologists,
- school of, p. 6, § 4½ *a, c;* p. 174–191, § 350½–351.

Chemical Compounds,
- their simplicity, p. 23, § 38; p. 25, § 46; p. 26, § 49, 50.

Chemical and Physical Views of Life,
- their moral and religious tendencies. See Life, God and Nature, and Vital Properties in the Elements of Matter.

Chemistry,
- its proper vocation, p. 14, § 6; p. 27, § 53; p. 26, § 48; p. 207, § 376¾ *b.*
- its home the Laboratory, p. 14, § 6; p. 203, § 376½; p. 227, § 447½ *f.*
- contradistinguished from Medical Philosophy, p. 8, § 5; p. 14, § 6; p. 19, § 18 *e;* p. 21–36, § 20–62; p. 149–207, § 337–376¾; p. 234–279, § 433–448.
- usurps medical philosophy, p. 8, § 5; p. 13, § 5½ *a;* p. 202, 203, § 376½.
- *a problem* for its solution, p. 281, § 450 *e;* p. 330, § 500 *n.*
- why it fluctuates, p. 14, § 6.
- its limits, p. 8, § 5; p. 14, § 6; p. 15, § 14 *b;* p. 16, § 15; p. 18, § 18; p. 24, § 42; p. 25, § 44; p. 27–29, § 53, 54; p. 161, § 350, No. 59; p. 202, 203, § 376½; p. 229, § 438 *d.*
- The Author's opinion of its value, p. 133, § 292; p. 207, § 376¾ *b.*
- as applied to Medicine illustrates forci-

Chemistry—*continued*.
bly the universal maxim, *ne sutor ultra crepidam*, p. 174–178, § 350½–350¾.

CHEMISTRY, MEDICAL,
now and sixty years ago, p. 8, § 5.
errors of, why successful, p. 10, 11, § 5½ *c*; p. 349 *d*; p. 202, § 376½; p. 234, 235, § 433.
admits, to the full extent, the principles of solidism and vitalism, p. 6, § 4½ *b*, *d*; p. 19, § 18 *e*; p. 22, § 29; p. 26, § 49; p. 30–33, § 59, 60; p. 37, § 64 *a*; p. 157–173, § 350, Nos. 47–96; p. 189, § 350¾ *n*. See, also, ORGANIC CHEMISTRY, and LIFE *in its connection with physical views*.

CHEMISTRY, ORGANIC. See ORGANIC CHEMISTRY.

CHILDHOOD,
its physiological and moral characteristics, p. 375–376, § 577.

CICUTA. See NARCOTICS, THERAPEUTICS, and VITAL HABIT.

CINCHONA, AND ITS ALKALOIDS, p. 596–607, § 892.

CIRCULATION OF THE BLOOD,
author's theory of, p. 207–217, § 377–399.
chemical theory of, p. 157–163, § 350, Nos. 3, 4, 5, 7, 8, 9, 10, 19; p. 175, § 350½; p. 208, 209, § 383 *a*, *b*; p. 274, § 447½ *a*; p. 329, § 500 *n*.
mechanical theory of, p. 208, § 383 *a*; p. 210, § 387; p. 212, § 391.
animalcular theory of, p. 208, § 383 *a*. See, also. CAPILLARIES, and CAPILLARY ACTION.

CIRCULATION, CAPILLARY,
chemical theory of, p. 157, 158, § 350, Nos. 3, 7, 8, 9; p. 208, 209, § 383; p. 274, § 447½ *a*, No. 3; p. 329, § 500 *n*.
physical views of, p. 99, § 192; p. 132, 133, § 289–292.
physiological experiments relative to. See HEART, ARTERIES, and PLANTS.

CIRCULATION, PORTAL,
author's theory of, p. 207, § 379; p. 211, § 390 *a*; p. 214, § 392 *c*.

CIRCULATION, VENOUS,
author's theory of, p. 209–212, § 384–392 *a*; p. 214, § 392 *d*.
and its bearing upon the pathology of *venous congestion*. See VENOUS CONGESTION, p. 500–513, and VENOUS TISSUE, and VEINS.

CLIMATE,
its physiological influences, p. 394–396, § 615–621.

COLLEGES, MEDICAL. See MEDICAL EDUCATION, and *note* there, GRADUATES, MEDICAL, and DEFENSE OF THE MEDICAL PROFESSION OF THE UNITED STATES.

COLOCYNTH. See CATHARTICS, THERAPEUTICS, and REMEDIAL ACTION.

COMBUSTION,
in Organic Chemistry, the cause of Animal Heat, p. 162, § 350, No. 17½; p. 178, § 350¾ *f*; p. 238, § 438 *b–d*; p. 239–247, § 440, Nos. 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 19; p. 276–278, § 447½ *f*.
the cause of the Vital Force or Vitality, p. 154, § 349 *c*; p. 157–170, § 350, Nos. 3, 4, 6, 8, 15, 18, 18½, 19, 31, 32, 36, 37, 38, 39, 40; p. 177, 178, § 350¾ *f*; p. 254, § 441 *e*; p. 274, § 447½ *a*.
the cause of all Organic Motions and Results, p. 158–170, § 350, Nos. 5, 6, 7, 8, 9, 10, 15, 19, 31, 32, 36, 37, 38, 39; p. 175, § 350½ *h–m*; p. 177, 178, § 350¾ *d–f*; p. 208, § 283; p. 254, § 440, No. 10; p. 254, § 441 *e*.
the cause of Voluntary Motion, p. 155, § 349 *e*; p. 329, § 500 *n*.
the cause of the Circulation of the Blood, p. 157–163, § 350, Nos. 3, 4, 5, 7, 8, 9, 10, 19; p. 175, § 350 *h–l*; p. 208, 209, § 383 *a*, *b*; p. 274, § 447½ *a*; p. 329, § 500 *n*.
the cause of Fever and Inflammation, p. 160, § 350, No. 10; p. 175, § 350½ *h–l*; p. 177, 178, § 350¾ *e*, *f*; p. 252, § 441 *c*.
the cause of Thought and Passions, p. 155, § 349 *e*.
the cause of Sleep, p. 329, § 500 *n*.
the cause of Respiration, p. 162, 163, § § 350, Nos. 18, 18½, 19, &c.; p. 248, 252, § 441 *b*, *c*.
the cause of Mortification, p. 175, § 350½ *m*.
and the cause of Death, p. 173, § 350, No. 46; p. 243, § 440 *cc*, No. 12.

COMPOSITION OF ORGANIC BEINGS, p. 23–49, § 32–82.
contrasted with that of mineral compounds, p. 20–27, § 19–51.
its requisites, p. 15, § 14.
elementary and proximate, p. 23, § 33.
of animals, nearly the same in all, p. 20, § 18 *e*; p. 25, § 45.
affected by disease, p. 25, § 44; p. 87, § 182 *a*.
mostly the same in animals and plants, p. 23, § 34–36.
consists of about seventeen elements, p. 23, § 34–36.
consists mostly of four elements variously combined, p. 23, § 37; p. 24, § 41; p. 27, § 52; p. 222–225, § 409.

COMPOUNDS, MINERAL,
few only, p. 25, § 46.
cause of their differences, p. 27, § 52, 53 *b*.
formed by the union of two elements, or by the union of binary compounds with another element, p. 23, § 38, 39.

Compounds, Mineral—*continued.*
their structure, p. 20, § 19.
their increase, p. 21, § 20.
how distinguished from organic beings, p. 15, § 7–14; p. 20–22, § 19–30.
COMPOUNDS, ORGANIC,
their variety contrasted with mineral, p. 24, 25, § 41, 46.
different in every part, p. 25, § 44; p. 27, § 53 *b*; p. 222–225, § 409.
always the same in health in any given part, p. 25, § 44; p. 27, § 53 *b*; p. 222–225, § 409; p. 227, § 411.
always modified in one exact way in any given state of disease, p. 222, 223, § 409; p. 537, § 847 *d*; p. 538, § 847 *f*, *g*. See, also, ORGANIC COMPOUNDS.
CONIUM. See NARCOTICS, and THERAPEUTICS.
CONGESTION, VENOUS, p. 500–513, § 786–818.
author's theory and investigation of, p. 500–513, § 786–818. See, also, VENOUS TISSUE.
CONSTIPATION, HABITUAL,
how best overcome, p. 567–569, § 889 *b*–889 *mm*.
or other attendant of indigestion often gives rise to chorea, epilepsy, &c., the philosophy explained, p. 323–332, § 500; p. 356–358, § 526 *d*.
CONSTITUTION, p. 383–385; p. 271–273.
CONTAGION,
limited by physiological laws, p. 418–420, § 652 *c*–653.
CONTRACTILITY. See MOBILITY.
COPAIVA. See GENITO-URINARY AGENTS.
COPPER, SULPHATE OF. See EMETICS, ASTRINGENTS, THERAPEUTICS, and REMEDIAL ACTION.
COUNTER-IRRITANTS, p. 642–660, § 893; p. 679–681, § 905.
supply an illustration of remedial action, p. 646–651, § 893 *e–i*; p. 679–681, § 905.
CREATOR,
an argument by the *author* in proof of, p. 16, § 14 *c*; p. 81, § 170 *a*. See, also, DESIGN.
contradistinguished from *Nature*, p. 16, § 14 *c*; p. 25, § 43; p. 46, § 74 *a*; p. 81, § 170 *a*; p. 83, § 172; p. 86, § 175 *d*; p. 124, § 241; p. 183–189, § 350 ¾ *i–m*; p. 227, § 411.
faith in a, necessary to philosophical views of life, p. 317, § 493 *a*. See DESIGN, and LIFE, *moral and religious tendencies of the Chemical and Physical Views of*.
CROTON OIL. See CATHARTICS, and REMEDIAL ACTION.
CUBEBS. See GENITO-URINARY AGENTS.
CUPPING,
its characteristic effects and uses, p. 702–703.

D.

DEATH, p. 401–404.
an extinction of the Vital Principle, p. 30, § 58; p. 31, § 59; p. 83, § 174; p. 96, § 189 *c*.
"DEBILITY,"
often fatally mistaken for the failure of the will to act upon the voluntary muscles, p. 296, § 476 *c*; p. 313, § 487 *gg*, *h*; p. 370–372, § 569; p. 724–728, § 961–964.
DECARBONIZATION OF BLOOD,
a vital function, p. 229, 230, § 419, 420; p. 274–278, § 447½.
DECOMPOSITION, VITAL,
balances nutrition, p. 34, § 62 *b*; p. 53, § 104; p. 129, § 273; p. 217, § 401.
governed by peculiar and established laws, p. 34, § 62 *b*. See, also, APPROPRIATION, and INFLAMMATION.
shows a radical difference between organic and inorganic beings, and the laws of each, p. 34, § 62 *b*; p. 217, § 401. See, also, PUTREFACTION, and ABSORPTION.
"DEFENSE OF THE MEDICAL PROFESSION OF THE UNITED STATES," p. 460–463, § 709, and *note*. See, also, MEDICAL EDUCATION, and *note* there.
DESIGN,
physiological proof of, p. 6, § 4½ *b*; p. 15, § 14 *b*; p. 24, § 40; p. 25, § 43, 46; p. 30, § 57; p. 34–36, § 62; p. 37, § 64; p. 44, § 72; p. 46, § 74; p. 51, § 83 *c*; p. 53, § 95; p. 55, § 117; p. 56, 57, § 121–125; p. 58, § 129 *d*; p. 59, § 130; p. 61, § 133 *c*; p. 62, § 136; p. 63, § 137; p. 65, § 143 *c*; p. 67–69, § 149–156; p. 81, § 169 *f*; p. 85, § 175 *c*; p. 87, § 180; p. 88, § 185; p. 93, § 188½; p. 97, § 190; p. 98, § 191; p. 99, § 192; p. 100, § 199; p. 102, § 201 *c*; p. 108, § 228 *a*; p. 110, 111, § 232–233¾; p. 122, § 239, 240; p. 125, § 246; p. 130, § 180; p. 129, § 273; p. 135, 136, § 298, 303 *a*; p. 137, 138, § 303¼ *b*, *c*; p. 141, § 307; p. 143–146, § 322–326; p. 148, 149, § 336; p. 191, 192, § 353, 354; p. 209, § 385; p. 210, § 387; p. 212, § 391; p. 216, § 398; p. 224, § 409 *f*; p. 227, § 411; p. 230–232, § 422–425; p. 234, § 433; p. 249, § 441 *c*; p. 251, § 441 *c*; p. 253, § 441 *d*; p. 280, § 449 *d*; p. 281, § 450 *e*; p. 284, § 455 *a*; p. 287, § 458; p. 290, § 464; p. 312, § 487 *g*; p. 323–332, § 500; p. 335, § 512 *a*; p. 376, § 578 *b*; p. 379, § 578 *d*; p. 391, § 603; p. 402, § 633; p. 405–412, § 638; p. 435, § 680; p. 472–474, § 732–733 *f*; p. 519, § 826 *a*; p. 536–539, § 847. In all the foregoing physiological evidences of *De-*

Design—*continued.*
sign, the proof will be greatly multiplied by associating the processes with the anatomical structure, in the several instances respectively. But the laws, processes, and results are by far the most important.
Development of Organs, p. 37–47, § 64–74; p. 68, 69, § 153–159; p. 373–380, § 574–578.
Diet,
importance of a careful regulation of, in disease, p. 61, 63, 67, § 133, 137, *d*, *e*, 151; p. 543, § 856; p. 600, § 892 *e*. See, also, Vis Medicatrix Naturæ.
Digestion, Physiology of, p. 147–207, § 332–376¾. Also, p. 15, 16, § 10, 13, 14, 16, 17, 18 *a*; p. 134–147, § 296–331.
chemical theory of, p. 167–170, § 350, Nos. 29–34; p. 197–199, § 362–364½.
carries forward, not backward, organic compounds, p. 15, § 13, 14; p. 16, § 16–18; p. 24, § 42; p. 30, § 59; p. 33, § 60; p. 135, § 301; p. 143, § 322; p. 196, § 360, 361; p. 201, § 374, 375.
Distribution,
description and philosophy of, p. 207–217, § 377–399.
Disease,
its philosophy sought in the ovum, p. 47–49, § 75–80.
hereditary, philosophy of, p. 47–49, § 75–80; p. 424, § 661.
coincident in animal and organic life, p. 55, § 117; p. 98, § 191 *a*.
influenced by relation of organs, p. 59, § 129 *g*.
influenced by vital constitution of tissues, p. 61, § 134; p. 64, § 138, 141, 142; p. 67, § 149–151; p. 69, § 158–162. See, also, Venous Tissue, and Sympathies of Tissues and Organs.
apt to continue in an invaded tissue, p. 64, § 141 *b*. See, also, Inflammation.
disturbs the entire organ, p. 64, § 141 *b*.
specific, extends from one to other tissues, p. 64, § 141 *b*.
invades different parts of a tissue, p. 65, § 142, 143.
its cure due to the mutability of the vital properties, p. 3, § 2 *b*; p. 61, § 133 *e*; p. 87, § 177–179; p. 119, § 234 *i*; p. 122, § 239; p. 478, § 740 *b*. See, also, Therapeutics.
philosophy of its cure, p. 67, 68, § 150–152; p. 662–665, § 895–901.
philosophy of its cure, in *Organic Chemistry*, p. 176–178, § 350¾ *a*.
force of, according to tissues affected, p. 72, § 162.

Disease—*continued.*
illustrates physiological states, p. 73, § 163; p. 265, § 447 *b*; p. 476, § 735 *b*. See, also, Age, Venous Tissue, and Venous Congestion.
depends upon the mutability of the vital properties, p. 3, § 2 *b*; p. 11, § 5¼ *e*; p. 47–49, § 74–80; p. 61, § 133 *c*; p. 87, § 177–182; p. 98, § 191; p. 121, § 237, 238; p. 352, § 524 *d*; p. 514, § 819 *a*, No. 5. See, also, Pathology.
consists, essentially, in changes of the organic properties, p. 3, § 2 *b*; p. 98, § 191 *b*. See, also, Pathology.
analysis of, in plants and animals, p. 98, § 191 *a*.
establishes special susceptibilities, p. 3, § 2 *b*; p. 63, § 137 *d*; p. 65, § 143; p. 67, § 149–152; p. 98, § 191 *b*. See, also, Pathology, and Therapeutics.
its effects conform to the causes, p. 105, § 220 *c*. See, also, Remote Causes of.
never occasions putrescency, p. 105, § 221. See, also, Humoralism, and Digestion.
epidemic, according to the nature of species, both of animals and plants, p. 98, § 191 *a*.
affects the vital relations of all agents, p. 3, § 2 *b*. See, also, *establishes special susceptibilities*, as above.
mode of investigating, p. 73, § 163; p. 437–442, § 685, 686; p. 561, § 888 *a*.
illustrative example of, in therapeutics, p. 430–433, § 675–676 *a*.
predisposition to, Author's philosophy of, p. 87, § 181; p. 368, § 559; p. 421, 422, § 657 *a*, *b*; p. 426, § 666; p. 429, 430, § 674 *d*.
Disease, Remote Causes of, p. 414–427, § 644–666.
Disease, Proximate or Pathological Cause of, p. 427–434, § 667–676.
Discoveries,
recognition of their priority useful as well as just, p. 93, § 188½ *d*; p. 290, § 462–464; p. 295, § 476 *a*, *b*; p. 308–310, § 484, 485; p. 319–321, § 494; p. 341, § 514½ *b*; p. 559, 560, § 883 *b*; p. 595, § 892 *a*; p. 614, § 892½ *d*; p. 620–622, § 892¾ *a*, *b*.
Dismemberment,
law of, p. 54, § 108, 109; p. 56, § 122, 123.
Diuretics,
their uses, and illustrations of remedial action, p. 630–633, § 892¾.
Doctrines, Rival,
should be compared and contrasted, p. 6–8, § 4½, 5; p. 19, § 18 *e*; p 157–173, § 350; p. 189, 190, § 350¾ *n*; p. 191, § 351; p. 219, § 407 *a*; p.

Doctrines, Rival—*continued.*
238, § 438 ; p. 246, § 440 *f;* p. 277, 278, § 447½ *f;* p. 514, § 819 *a*, Nos. 1–7.
Doses of Medicine, &c.,
the importance of accuracy in, p. 543–545, § 857–860 ; p. 568, 569, § 888 *m, mm;* p. 590, § 891 ; p. 598–604, § 892 *d–l.*
Ducts, Living,
have no analogy in office with inert tubes, p. 99, § 192.
their functions identified with the capillary attraction of glass tubes, sponges, and lamp-wicks, p. 99, § 192 ; p. 132, 133, § 289–292. See, also, Capillary Attraction, Capillary Circulation, Absorption, and Appropriation.

E.

Education, Medical,
in Europe and the United States, its disproportion. See Medical Education.
Effects,
causes of, important to know, p. 4, § 3–4 ; p. 80, § 169 *d.*
the foundation of philosophy, p. 10, § 5¼ ; p. 112–122, § 234–240.
evince their causes, p. 80, § 169 ; p. 112–121, § 234–237. See, also, Design.
the sources of knowledge, p. 2, 3, § 2 ; p. 50, 51, § 83 *c.*
the language of disease and of all existences and causes, p. 112–121, § 234–237. See, also, Remote Causes of Disease.
Elaterium, p. 655, 656, § 893 *n*, and Cathartics, and Remedial Action.
Elements of Organic Beings, p. 23, § 34–37 ; p. 33–36, § 61, 62.
how combined, p. 23, § 38, 39. See, also, Nitrogen, and Vital Properties *in the Elements of Matter.*
Elements of Dead Organic Compounds,
how maintained in union, p. 30, 31, § 59. See, also, Nitrogen.
Elements of Mineral Compounds,
how united, p. 23, § 38 ; p. 26, § 48, 49.
Electricity. See Galvanism.
Emetics,
physiology of their operation, and their effects, p. 325, 326, § 500 *e, ee;* p. 336, 337, § 514 *b, c;* p. 547–550, § 863 *d;* p. 667–669, § 902 *e–g.* See, also, Sudorifics, and Nervous Power.
contrary to the general fact, p. 63, § 137 *d*, the stomach may be rendered by certain forms of disease more or less insusceptible to their action, as sometimes seen in croup, where, too, there is a special modification of inflammatory action in the mucous tissue of the larynx ; and particularly by narcotics, p. 61, § 134 ; p. 64, § 140 ; p. 374, § 576 *d;* p. 554, § 871, &c.
when given in small and repeated doses in whooping-cough, so that an emetic effect is determined by the cough, the paroxysm is broken according to the physiological influence of the nervous power as stated at p. 337, § 514 *c.* Also, p. 323–332, § 500 ; p. 548, 549, § 863 *d;* p. 670, § 902 *m.*
the examples reach far into the philosophy of the operation of the nervous power. See Remedial Action, and Antispasmodics.
when employed in fever, often most useful to administer calomel, with or without jalap, two or three hours before, p. 554, § 871, &c.
Emotions. See Mental Emotions.
Emollient Poultices. See Poultices.
Emmenagogues, p. 628–629. See, also, Genito-Urinary Agents, Ergot, and Amenorrhœa.
Endosmose and Exdosmose, p. 176, § 350½ *n;* p. 219, § 407 *b*, 408 ; p. 320. § 494 *dd;* p. 521–525, § 827. See, also, Gases.
Epsom Salts. See Cathartics, Therapeutics, and Remedial Action.
Ergot,
discovery of its uses, its importance to mankind, &c., p. 620–628, § 892¾.
Errhines,
their operation, p. 340, 341, § 514 *l, m.*
Error,
should be contrasted with truth, p. 2, § 1 *b;* p. 6–8, § 4½, 5 ; p. 19, § 18 *e;* p. 157–173, § 350 ; p. 189, 190, § 350¾ *n;* p. 191, § 351 ; p. 219, § 407 *a;* p. 238, § 438 ; p. 246, § 440 *f;* p. 277, 278, § 447½ *f;* p. 433, 434, § 676 *b;* p. 463, § 709 ; p. 482, § 744 p. 514, § 819 *a*, Nos. 1–7.
will be freely examined, p. 2, § 1 *b.*
its exposure necessary to truth, p. 2, § 1 *b;* p. 6, § 4 *b;* p. 515, § 819 *b.*
involves argumentative discussion, p. 1, § 1 *b;* p. 5, § 4 *b.*
surrenders reluctantly, p. 2, § 1 *b;* p. 5, § 4 *b;* p. 268, § 447 *d.*
why preferred to truth, p. 202, § 376¼ ; p. 313, § 487 *h.*
itself, not the *Author*, the subject of criticism, p. 6, § 4 *b;* p. 154, § 349 *d.*
its *Sources, Authorities*, and *Extent* should be known, p. 154, § 349 *d;*

Error—*continued.*
p. 185–189, § 350¾ *kk–m;* p. 515, § 819 *b.*
engages the highest order of mind, p. 6, § 4 *b;* p. 154, § 349 *d;* p. 184, 185, § 350¾ *k, kk;* p. 204, § 376¾ *a;* p 476, § 733 *k;* p. 719, § 960 *a.*
often springs from a misapplication of facts, p. 10, 11, § 5¼; p. 518, § 823.
often arises from some absent fact, p. 10, § 5¼ *c.*
springs from a mutilation of facts, p. 10, § 5¼ *c;* p. 518, § 823. See, also, Organic Chemistry, Organic Heat, and Physiology of Digestion.
leads to a disregard of consistency, p. 11, § 5¼ *c;* p. 519, § 824 *a.* See, also, Organic Chemistry, its Recommendations.
hasty generalization, a source of, p. 10, § 5¼ *c.*
relies upon the senses, p. 11, § 5¼ *c;* p. 111–121, § 234–237; p. 518, § 823.
ambition, a prolific cause of, p. 11, § 5¼ *d;* p. 202, § 376½.
delights in false analogies, p. 10, § 5¼ *a;* p. 11, § 5¼ *c;* p. 13, § 5½; p. 157–173, § 350, Nos. 1–46; p. 234–260, § 433–443; p. 274–278, § 447½; p. 518, 519, § 823, 824.
its most ingenious devices, p. 2, § 1 *b;* p. 184, § 350¾ *k.*
one the parent of another, p. 762, § 1006 *a.*
coincidences in its nature, p. 762, 763, § 1006 *a.*
how best defeated, p. 176, § 350¾ *a;* p. 191, § 351; p. 515, § 819 *b.*
its refutation should contemplate extensive and permanent influences, p. 174, § 350¼.
how far *tolerant,* p. 13, § 5½ *a;* p. 156, § 350 *a–e;* p. 185, § 350¾ *kk;* 204, § 376¾ *a;* p. 515, § 819 *b.*
who are its projectors, p. 516, § 820 *b.*
its perseverance under defeat, p. 153, § 349 *a;* p. 516, § 820 *c.*
an important cause of its prevalence, p. 184, § 350¾ *k;* p. 515, § 819 *b.*
its exact distinction from truth, p. 166, § 350, No. 28, and parallel columns, p. 157–173. See Facts.
Excretion,
a function of organic life; its nature, &c., p. 227–234.
analogous to secretion, but differs in its final cause, and does not give rise to true organic compounds, *ibid.*
Excretions and Secretions,
as supplying symptoms, p. 450–455.
Exdosmose. See Endosmose.
Expectorants, p. 633–644, § 892⅘.
many of them being stimulant to the extreme vessels, as well as to the general organs of circulation, are

Expectorants—*continued.*
morbific in active forms of inflammation, *ibid.*, and Nervous Power.
few, only, useful as curative agents.
some of them, as sulphate of zinc, excite but little perspiration, *ibid.*
a mistaken view of the pathology of phthisis pulmonalis, and an inconsiderate use of the stimulating expectorants, important causes of the great fatality of that disease, *ibid.*, and its hypothetical nature leads to important errors in practice, *ibid.*
Experimental Observation in Medicine,
nature of, p. 11, § 5¼ *e, f;* p. 148, § 334; p. 518, § 823.
imposes restraints upon art, p. 11, 12, § 5¼ *e, f.* See, also, Therapeutics.
Experiments to determine the Laws of the Vital Functions, p. 295–331, § 476–494.
"Experimental Philosophy." See Medicine, *vitiated by.*
Extreme Vessels,
the main instruments of organic life. See Capillaries and Extreme Vessels.
Eye,
of subterranean fish, developed by light, p. 46, § 74.
its rudimentary state, p. 46, § 74.
Author's explanation of its development, p. 46, § 74; p. 671, § 903.
action of light upon, analogous to that of all other vital agents, p. 46, § 74; p. 90–95, § 188½ *d.* See, also, Analogies.
Author's explanation of action of light in animal and organic life, p. 90–95, § 188½ *d.*

F.

Facts,
importance of, p. 10, § 5¼; p. 515, § 819 *b.*
in medicine, the phenomena of organic nature, p. 10, § 5¼ *b;* p. 202, § 376½; p. 519, § 824 *a.*
who may apply them best, p. 10, § 5¼ *a;* p. 115, 116, § 234 *e, f;* p 119, § 235; p. 202, § 376½; p. 207, § 376¾ *b;* p. 247, § 440 *h.*
how employed by the vitalist, p. 10, § 5¼ *a, b;* p. 14, § 6; p. 75, § 165 *b;* p. 279, § 448 *f;* p. 330, § 500 *n;* p. 515, § 819 *b.*
how far neglected by the Chemical Physiologist, p. 10, § 5¼ *a;* p. 14, § 6; p. 202, 203, § 376½; p. 519, § 824 *a.* See, also, Organic Chemistry, its Recommendations, and Humoralism.
false conclusions from, prolific of error, p. 10, § 5¼; p. 202, 203, § 376½. See, also, Error, Organic Chemistry and Humoralism.

Facts—*continued.*
often just otherwise, p. 10, § 5¼ *a;* p. 19, § 18 *e*, A. C.; p. 157–173, § 350, Nos. 1–46; p. 189, 190, § 350¾ *n;* p. 191, § 351; p. 238, § 438; p. 246, § 440 *f;* p. 277, 278, § 447½ *f;* p. 433, 434, § 676 *b;* p. 460, § 709 *note;* p. 482, § 744; p. 514, § 819 *a*, Nos. 1–3; p. 518, § 823.
relative to organic beings, can not be found in the laboratory, p. 10, § 5¼ *b;* p. 14, § 6; p. 202, § 376½; p. 519, § 824 *a*.
each one too apt to be regarded abstractedly, p. 10, § 5¼ *b*.
should be compared, p. 10, § 5¼ *b*. See, also, *often just otherwise*, as above.
the importance of one among many, p. 10, § 5¼ *b*.
when plausible, can not contradict established ones, p. 10, § 5¼ *b*. See, also, *often just otherwise*, as above.
mutilated to suit hypotheses, p. 10, § 5¼ *c;* p. 519, § 824 *a*. See, also, *often just otherwise*, as above, and ORGANIC CHEMISTRY, ITS RECOMMENDATIONS.
greatly neglected, p. 112, § 234 *b*.
between the physiologist and physical philosopher of life, p. 115, § 234 *e;* p. 519, § 824 *a*.
how to employ them to the best advantage, p. 515, § 819 *b*. See, also, AUTHORS.
"become old," p. 420, § 654 *a*.

FERMENTATION,
its cause and peculiarities, p. 28–31, § 54–59; p. 34–36, § 62.
inapplicable to physiological processes, p. 167, § 350, Nos. 29, 78.
important in the Chemical and Humoral Pathology, p. 172, § 350, Nos. 44, 45. See, also, HUMORALISM.

FEVER, p. 489–499.
description of, p. 489–497.
remote Causes of, p. 497–498.
pathological Cause of, p. 498–499. See, also, INFLAMMATION, *distinguished from Fever*.

FISH, *eyeless*,
action of light upon, p. 46, § 74 *a*. See, also, LIGHT.

FŒTUS,
the simplicity of its life, p. 53, § 103.
AUTHOR'S philosophy of its development, p. 36–49, § 63–80.
its animal and mental faculties passive. See MIND and INSTINCT.
early development of its nerves, like that of the liver, kidneys, organs of animal life, &c., consistent with their dormant state, p. 284, § 455 *a*, *b;* p. 286, § 456; p. 289, § 461½ *a;* p. 342–353, § 516–524.
Erratum, p. 56, line 19 from bottom,

Fœtus—*continued.*
after *fœtus* add, *and according to its subsequent relative uses.*

FOOD,
of ANIMALS, known only by experience, p. 17–20, § 18; p. 200, 201, § 366, 367.
can not be shown by chemistry, p. 17–20, § 18.
like physiology, pathology, and therapeutics, consigned to the laboratory, p. 234, 235, § 433.
of PLANTS, chemistry may indicate with great advantage, p. 20, § 18 *e*.
importance of a right quality of, in diseases, p. 250–252, § 441 *c;* p. 543, § 856; p. 600, § 892 *e*.

FOMENTATIONS. See POULTICES.

FORCES OF NATURE,
prove a CREATOR, p. 16, § 14 *c;* p. 81, § 170. See, also, DESIGN, and NATURE CONTRADISTINGUISHED FROM CREATIVE POWER.

FOURCROY,
sixty years ago, p. 8, § 5; p. 203, § 376½.

FUNCTIONS OF LIFE, p. 125–372.
effects only, p. 86, § 176; p. 120, § 235.
the great ends of life, *ibid.*
mistaken as the cause of life, *ibid.* See, also, LIFE, VITAL PRINCIPLE, VITAL PROPERTIES, NERVOUS POWER, SYMPATHY, and LAWS OF SYMPATHY.

FUNCTIONS, ORGANIC, OR COMMON, p. 126–280.
PECULIAR, OR ANIMAL, p. 280–362.
OF RELATION, p. 280–362.
RELATION TO THE MENTAL PRINCIPLE AND INSTINCT, p. 362.
MODIFICATIONS OF, ARISING FROM AGE, TEMPERAMENT, CONSTITUTION, SEX, CLIMATE, HABITS, &C., p. 373–397.

G.

GALVANISM AND ELECTRICITY,
their modifications applied to illustrate the philosophy of life and disease, p. 114, § 234 *d*.
their extended application to the philosophy of life, p. 93, 94, § 188 *d;* p. 112–121, § 234–237; p. 323–332, § 500.

GAMBOGE. See CATHARTICS, and THERAPEUTICS.

GANGLIONIC OR SYMPATHETIC SYSTEM,
general Facts and Laws relative to, and to the Cerebro-Spinal, p. 335–341.
its Laws of Action, and Propagation of Impressions in it, p. 341, 342.
its Laws of Action in Involuntary Motions, p. 342–349.
laws of its Sensitive Functions, p. 350.
laws of its Organic Functions, p. 350–353. See, also, SYMPATHETIC NERVE

GASES, AND ETHEREAL VAPOR,
effects of their respiration disprove the doctrines of Humoralism, p. 522, 523, § 827 *b, c.*
their behavior in chemical physiology, p. 175, 176, § 350½ *n–p.* See, also, ENDOSMOSE AND EXDOSMOSE.
absorption of Carbonic Acid shown physiologically to be improbable; and that its instant operation as a destructive agent upon man and animals is a farther proof, p. 522, 523, § 827; p. 672, § 904 *b.*
GASTRIC JUICE,
can be generated by nothing in Nature but the mucous tissue of the stomach, p. 62, § 135 *a;* p. 141, § 307; p. 191, 192, § 353; p. 201, § 374, 375. See, also, DIGESTION, PHYSIOLOGY OF, and MUCOUS TISSUE.
its *manufacture*, p. 197–199, § 362–364½.
GENERATION, p. 279–280, § 449.
its physiology, p. 36–49, § 63–81.
illustrates the organic properties, p. 44, § 72; p. 97, § 190 *b.*
proves a coincidence in the life of plants and animals, p. 56, § 121–123; p. 280, § 449 *d.*
GENERATION, ORGANS OF, p. 55, § 118–121.
their influences in organic and animal life, p. 56, § 120; p. 376–380, § 578.
their importance in organic Design, p. 56, § 121–123; p. 280, § 449 *d.*
GENERATION, SPONTANEOUS,
how it happens, p. 178–184, § 350¾ *a*–350¾ *g;* p. 186, 189, § 350¾ *kk*–350¾ *m.*
disproved, p. 16, § 14 *c.*
inconsistent with Creative Power, p. 81, 82, § 170.
GENITO-URINARY AGENTS, p. 683–689, § 905½.
GERM. See OVUM, and SEED.
GERMINAL DISK,
the potential whole, p. 41, § 65.
GILLENIA. See EXPECTORANTS, EMETICS, and THERAPEUTICS.
GOD AND NATURE,
confounded, p. 40, § 64 *h;* p. 46, § 74 *a;* p. 76, § 167 *b;* p. 86, § 175 *d;* p. 178–189, § 350¾ *a*–350¾ *m.*
confounded in the same way as the vital force and chemical forces, or as mind and matter, where there is less motive for concealment, p. 154. § 349 *c;* p. 182, 183, § 350¾ *gg;* p. 189, 190, § 350¾ *n.* See, also, VITAL PROPERTIES IN THE ELEMENTS OF MATTER, and PROBLEMS.
contradistinguished, p. 16, § 14 *c;* p. 25, § 43; p. 46, § 74 *a;* p. 81, § 170 *a;* p. 83, § 172; p. 124, § 241; p. 227, § 411.
the Latter the Interpreter of the *Former*, p. 186, § 350¾ *kk;* p. 227, § 411; p. 317, § 493 *a.* See, also, DESIGN.
GRADUATES, MEDICAL,
their disproportion in Europe and the United States, connected with a greater disproportion of Medical Colleges, and other facts adduced by the AUTHOR, evince the great superiority of the American over the European Medical Profession. See MEDICAL EDUCATION, and DEFENSE OF THE MEDICAL PROFESSION OF THE UNITED STATES.
GRATITUDE,
due from physicians to their enlightened predecessors. See DISCOVERIES. Also, MEDICAL AND PHYSIOLOGICAL COMMENTARIES, vol. ii., p. 676, 677, § 801–815.
GRANULATIONS,
their office, p. 473, § 733 *c.*
GROWTH,
its philosophy sought in the germ, p 37–47, § 64–74.
its subsequent progress, p. 68, 69, § 153–159; p. 373–383, § 574–584. See, also, APPROPRIATION.
GUAIACUM, COLCHICUM, CINCHONA, COBWEB, ALCOHOL, &c.,
illustrate disease, specific action, &c., p. 417, § 650; p. 424, § 662 *a;* p 430, § 675, 676 *a;* p. 488, § 756 *a;* p. 553, § 870 *aa;* p. 562, § 888 *c;* p. 587, § 892 *c;* p. 676–679, § 904 *c.* See, also, REMEDIAL ACTION, ASTRINGENTS, ALTERATIVES, and ADAPTATION, LAW OF.

H.

HABIT, VITAL,
its physiological and moral laws and phenomena, p. 363–370, § 535–568.
HABITS, OR USAGES,
their physiological influences, p. 396–397, § 622–624.
HEART,
experiments to determine the Principle upon which its Action and that of the Vessels of Circulation depend, p. 295–301. See, also, DISTRIBUTION.
experiments relative to its Connection with the Nervous System, p. 301–305.
HEART AND ARTERIES,
sympathize more than other parts with local inflammations, especially acute, p. 354, 355, § 526 *a.* See, also, INFLAMMATION.
their sympathies not often inflammatory nor profound, *ibid.*
the *extreme vessels* more apt than the heart and arteries to sympathize with chronic inflammations, and with other forms of disease, and thus to result, sympathetically, in various morbid conditions, *ibid.*

Heart and Arteries—*continued.*
the foregoing are important distinctions, practically and philosophically, *ibid.* See, also, BLOOD-VESSELS and CAPILLARIES.
HEAT, OF ANIMALS AND PLANTS, p. 234–279, § 433–448.
EXTERNAL, resisted in the same way as chemical agents, p. 30–33, § 59, 60; p. 258, § 442 *d.*
INTERNAL, how generated, p. 262–273, § 445 *f*–447 *h.* See, also, COMBUSTION, and ORGANIC HEAT.
HEMORRHAGE, SPONTANEOUS,
its philosophy, advantages, &c., p. 572–575; p. 770–772. See, also, SUDORIFICS.
HELLEBORE. See CATHARTICS, THERAPEUTICS, and EMMENAGOGUES.
HOMŒOPATHY,
what doses of any cathartic, or emetic, will prove purgative, or produce vomiting, or may be necessary to affect diseases remote from the intestinal canal? The answer will be a general test of the applicability of the mathematical principle to the graduation of remedial doses. A common philosophy, in that respect, pervades the Materia Medica, p. 67, § 149–151; p. 541, 542, § 854 *bb*; p. 543–544, § 857; p. 545, § 859; p. 553, § 870 *aa*; p. 558, § 878; p. 602–605, § 892 *i–m.*
HOSPITAL REPORTS AND PRECEPTS,
compared with private practice, p. 420, § 654 *a*; p. 482, § 744; p. 457, § 699 *c*; p. 460–463, § 709; p. 573, § 890 *d*; p. 603, 604, § 892 *k*; p. 721, § 960 *c.* See, also, *Essay on the Writings of M. Louis, in Medical and Physiological Commentaries*, vol. ii, p. 631–633, 679–815.
HUMORALISM, p. 514–540.
contradistinguished from *Solidism* and *Vitalism*, p. 147, § 330; p. 516–518, § 821–822; p. 540, § 851; p. 550, 863 *e.*
has no physiological principle, p. 147, § 330; p. 558, § 878.
AUTHOR's physiological objection to, p. 534–540, § 845–851.
HUMORAL PATHOLOGY. See HUMORALISM.
HYBRIDS,
illustrate the philosophy of life, p. 44, § 72.
HYDROCYANIC ACID,
its mode of operating, rapidity of its effects, &c., p. 318–321, § 493 *d*–494; p. 523–525, § 827 *d*–828 *c*; p. 673, § 904 *b.*
HYOSCYAMUS. See NARCOTICS, and THERAPEUTICS.
HYPOTHESES,
the ground of, p. 10, § 5½ *b*; p. 202, § 376½; p. 518, 519, § 823, 824.

I.

IDIOSYNCRASY, p. 383–385.
IGNORANCE,
opposes itself to knowledge, p. 112, § 234 *b.*
IMAGINATION,
power of as a remedial agent, p. 534, § 844; p. 541, 542, § 854 *bb*; p. 558, § 878.
IMPONDERABLES,
any number, p. 84, § 175 *bb.*
agents, not the *causes*, in organic beings, p. 46, § 74; p. 90–95, § 188½; p. 113, § 243 *c.*
their analogies with the principle of life, p. 113–121, § 234 *c*–237.
applied to illustrate the philosophy of life, p. 93, 94, § 188½ *d*; p. 112–121, § 234–237; p. 323–332, § 500.
INDIGESTION,
often the slow result of a long series of causes, p. 423, § 659.
its train of maladies illustrate the laws of sympathy. See LAWS OF, &c., and NERVOUS TEMPERAMENT.
renders the mind irritable, and weak minds despondent.
INDIVIDUALITY,
of diseases and their phenomena, p. 4, § 2 *e*; p. 417, § 650.
INFANCY,
its physiological characteristics, p. 373–375, § 576.
INFIDELITY,
its exposure, a duty of the Physiologist, p. 6, § 4 *b.* See, also, DESIGN, and NATURE CONTRADISTINGUISHED FROM ITS AUTHOR.
INFLAMMATION, p. 464–489.
description of, p. 460–480.
remote Causes of, p. 480–481.
pathological Cause of, p. 482–489.
active and Passive, p. 486–489.
its philosophy, p. 99, § 192.
its vital nature shown by a fundamental law in pathology, p. 413, § 639 *a*; and by the analogy between the adhesive process of, and the diseases and reparation, ingrafting, &c., of plants, and which is also illustrative of the nature of each, of their dependence upon modes of action as nearly allied as are the modifications of their common properties and functions of life, and of the near identity of their properties and functions, p. 88, § 185; p. 474–476, § 733 *f–k*; p. 485, 486, § 749–751. See, also, PLANTS.
excited by dividing nerves, p. 107, § 224.
its sympathetic or constitutional effects; see above, and FEVER. I add, that the dependence of the "fever"

Inflammation—*continued.*
upon the local disease, and other distinctions between true fever and inflammation, are well shown by the apparently opposite constitutional effects of poisonous doses of arsenic; as they may happen to produce inflammation in the gastro-mucous membrane of one subject and not of another. The difference proves, also, that the poison does not operate at large by absorption, but according to its special effects upon the stomach. See the principle, p. 665–670, § 902; p. 679–681, § 905. Also, HUMORALISM.
distinguished from FEVER. I add to the distinctions which I have set forth in sections 141 *b*, 148, 675, 712–722, 757, 759, 764 *a*, 764 *e*, 770, &c., that when inflammation is attended by a chill, this phenomenon generally happens only when the disease is on the decline; that is to say, when suppuration is taking place. In fever, on the contrary, it denotes the stage of the most intense morbid action.
chemical theory of, and of Fever, p. 160, § 350, No. 10; p. 175, § 350½ *h–l*; p. 176, 177, § 350¾ *a*, 350¾ *e*.

INORGANIC KINGDOM. See KINGDOMS OF NATURE, ORGANIC BEINGS, ORGANIC LIFE, &c.

INSTINCT,
common to man and animals, p. 123, § 241 *a*.
in animals, destitute of the rational faculty, p. 123, § 241 *a*. See, also, MIND, and REASON.
appertains to the soul in man, p. 123, § 241 *a*.
the compound attributes of reason and instinct in man, and the simple state of instinct in animals, meet with mutually illustrative analogies in the relative conditions of the principle of life in animals and plants, p. 123, § 241 *a*; p. 88, § 184, 185; p. 369, § 563; while other and greater physical coincidences between man and animals, and the fundamental distinctions between them, destroy the argument, based upon analogies, as to the identity of the soul and the instinctive principle, *ibid.*
endowed with understanding in animals, p. 123, § 241 *b*.
its affinity to the soul in certain attributes, p. 123, § 241 *c*.
contrasted with reason, p. 123, 124, § 241 *c*.
its manifestations far greater in animals than in man, p. 123, § 241 *c*.
progressive in man, but little so in animals, p. 123, 124, § 241 *c*; p. 369, § 563.
scarcely susceptible of cultivation in man, but remarkably so in many animals, *ibid.*
proof from, along with reason, of one species of mankind, p. 123, § 241 *c*, *note*.
developed before reason, p. 123, § 241 *c*.
its inferiority in man compared with animals, compensated by reason, p. 123, § 241.
its inferiority in man designed to increase his moral responsibility through the exercise of reason.
sufficient in man for the preservation of life.

INSTITUTES OF MEDICINE,
their objects, p. 2, § 2.
their consistency, a test of their truth, p. 1, § 1; p. 3, § 2 *c*; p. 81, § 169 *f*; p. 331, § 500 *o*; p. 405–412, § 638.
their foundation, p. 1, § 1; p. 22, § 31.
conducted analytically, p. 1, § 1.
a connected chain throughout, p. 1, § 1; p. 405–412, § 638.
should be studied progressively, p. 1, § 1.
now first attempted in their proper objects and natural relations, p. 1, § 1.
will be contradicted by collisions of principles or facts, p. 1, § 1; p. 3, § 2 *c*; p. 259, § 442 *e*. See, also, THEORIES, RIVAL.
pervaded by the spirit of the MEDICAL AND PHYSIOLOGICAL COMMENTARIES, p. 2, § 1 *a*.
should form one great symmetrical whole, p. 3, § 2 *c*; p. 405–413, § 638, 639 *a*; p. 541, § 852.
when founded upon any other than a simple principle, the superstructure must be incongruous, chaotic, p. 2–4, § 2, 3; p. 173–178, § 350¼–350¾. See, also, ORGANIC CHEMISTRY AND PHYSIOLOGY, *contrasted*.
fundamentally distinct from all other inquiries, p. 5, § 4 *b*; p. 8, 9, § 5; p. 14, § 6; p. 19, § 18 *e*; p. 157–182, § 350–350¾ *g*; p. 189, 190, § 350¾ *n*; p. 191, § 351; p. 246, § 440 *f*; p. 277, 278, § 447½ *f*.

INTESTINAL CANAL,
potential whole of digestive system, p. 41, § 65.

IODINE, p. 612–620. Also, THERAPEUTICS, and REMEDIAL ACTION.

IRIS,
physiology of its contraction, and application of in medicine, p. 328, § 500 *l*; p. 340, § 514 *k*. See, also, REMEDIAL ACTION.

IRRITABILITY,
an important property of the Vital Principle, p. 88, § 183; p. 89, § 188 *a*.

Irritability—*continued.*
common to plants and animals, p. 88, § 184 *a*, 185.
receives the impressions from all agents in the essential processes of organic life, p. 89, § 188 *a;* p. 95, 96, § 189.
variously adapted by special natural modifications to vital agents, p. 43–47, § 70–74 ; p. 62, 63, § 136, 137 ; p. 88, § 185 ; p. 89–99, § 188–192 ; p. 662–664, § 896–900.
its natural modifications in different parts, &c., important in medicine, p. 63, § 137 ; p. 64, § 141, 142 ; p. 66, § 143 ; p. 67, § 149, 150 ; p. 68–73, § 152–163 ; p. 89–99, § 188–192 ; p. 210, § 387 ; p. 503, 504, § 794–798.
naturally modified in each species of animal and plant, germ, part, &c., p. 97, 98, § 190, 191.
its morbid changes, p. 63, § 137 *d;* p. 65–68, § 143–152 ; p. 98, § 191 *b*.
according to its natural modification in a general, or local, sense, will be the operation of natural, morbific, and remedial agents, p. 61, § 133 *b*, 134 ; p 62, 63, § 135–137 ; p. 64, § 138 ; p. 66–68, § 148–152 *a;* p. 73, § 163 ; p. 97, 98, § 190, 191 ; p. 99, § 192. See, also, analogies in Sensibility, p. 100–103, § 199–204.
its morbid changes alter the relations and actions of all natural, morbific, and remedial agents, p. 63, § 137 *d;* p. 65, § 143 *a*–143 *c;* p. 66, § 144–147 ; p. 67, 68, § 149–152 ; p. 73, § 163 ; p. 98, § 191 *b;* p. 541, 542, § 854 *bb*.
its morbid changes generally increase the susceptibility of organs to the action of natural or remedial agents, *ibid*, and p. 661–664, § 894 *b*–900 ;—though sometimes lessen the susceptibility, especially to agents of certain virtues, p. 365–368, § 551–560.
may be increased through exalted sensibility, p. 104, § 110 ; p. 586–589, § 891 *g–m*.
its morbid changes allow the absorption of morbific agents, p. 99, § 192 ; and admit the red globules into white-blooded vessels, *ibid;* and allow undigested food to pass the pylorus, *ibid*.
a guard to the organism, p. 99, § 192.
belongs to all parts, p. 89, § 188 *a*.
described, p. 89–100, § 188–193.
necessary to motion, p. 89, § 188 *a;* p. 107, § 226 ; p. 110, § 233.
and *Sensibility* receive the impressions of all natural, morbific, and remedial agents, p. 89–103, § 188–204 ; p. 104, § 210 ; p. 107, § 226 ; p. 110, § 233 ; p. 323–332, § 500.

Irritability—*continued.*
distinct from *Sensibility*, p. 99, § 193 ; p. 104, § 110.
its natural modifications like those of *Sensibility*, p. 98, § 191 ; p. 100, § 200 ; p. 102, § 203 ; p. 108, § 227
its artificial changes analogous to those of the *nervous power*, p. 107, § 225 ; p. 110, § 232.
its general relations to external objects, p. 398–400, § 626–630.
Ipecacuanha. See Therapeutics, Remedial Action, Vital Habit, Emetics, Expectorants, and Sudorifics.
Iron. See Tonics.
important in the chemical philosophy of organic processes and results, p. 274–278, § 447½.

J.

Jalap. See Cathartics, Therapeutics, and Remedial Action.

K.

Kingdoms of Nature. See Nature, Kingdoms of.
Kino. See Astringents.
Knowledge,
its limits and objects, p. 120, § 235 , p. 185, § 350¾ *k*.
its accumulative nature, p. 206, § 376¾ ; p. 719–720, § 960 *a*.

L.

Lacteals. See Absorption, Nutrition, Tissues, and Structure.
Laws of Nature,
have no "exceptions," p. 120, 121, § 237 ; p. 131, § 285 ; p. 345, § 516 *d*, No. 6 ; p. 383, § 584 ; p. 397, § 623. See Nature, Organic Beings, Light, Vital Properties, &c.
Leeching,
its uses and peculiar effects, p. 692–698.
Life,
a cause, p. 30, § 57–59 ; p. 83–88, § 175–185 ; p. 96, § 189 *c;* p. 120, § 136 ; p. 401, § 631 ; p. 435, § 680 ; p. 474, 475, § 733 *f–i*.
essentially the same in plants and animals ; see Plants.
its philosophy learned from a wide observation of Nature, p. 4, § 2 *e;* p. 14, § 6 ; p. 207, § 376¾ *b*.
"discovered in *dead* matter," p. 179, § 350¾ *c*. See, also, Vital Properties in the Elements of Matter.
its phenomena seen distinctly or confusedly, p. 4, § 2 *e;* p. 157–173, §

Life—*continued.*
350 ; p. 189, 190, § 350¾ *n*; p. 276–278, § 447½ *f*; p. 777, *Pomfret.*
a knowledge of, requires habits of analytical observation, p. 4, § 2 *e*; p. 14, § 6 ; p. 313, § 487 *h*. See, also, OBSERVATION.
its study compared with that of botany, p. 4, § 2 *e*.
simple in fundamental laws, complex in its phenomena, p. 4, § 2 *e*; p. 662–664, § 895–899. See, also, ADAPTATION, and DESIGN.
general Remarks upon, p. 111–122, § 234–240.
considered a metaphysical subtilty, p. 112, § 234 ; p. 482, § 744.
moral and religious tendencies of the Chemical and Physical views of, p. 6, § 4½ *b*; p. 8, § 5 ; p. 11, § 5¼ *c*; p. 13, § 5½ *a*; p. 16, § 14 *c*; p. 46, § 74 ; p. 84–86, § 175 *c*, 175 *d*; p. 95, 96, § 189 *b*; p. 135, 136, § 303 *a*; p. 137, 138, § 303¼ *b*, *c*; p. 141, § 307 ; p. 155, § 349 *e*; p. 178, § 350¾ *a*; p. 181–189, § 350¾ *f*–350¾ *m*; p. 234, § 433 ; p. 458, 459, § 701, 704. See ORGANIC LIFE, and PLANTS.
LIFE, ANIMAL,
connects us *sensibly* with external objects, p. 53, § 100 ; p. 399, § 628.
requires repose, p. 53, § 102.
not pronounced in the fœtus, p. 53, § 103. See, also, NERVES, SENSIBILITY, NERVOUS POWER, SYMPATHY, and ORGANIC LIFE.
"animal life" is employed in its popular sense, at p. 135, § 301 ; p. 137, § 303½ *a*; p. 140, § 304.
LIFE, ORGANIC AND ANIMAL,
their distinctions and relations, p. 53–56, § 96–120.
diseases of, coincident, p. 55, § 117. Their relations to external objects, p. 398–400, § 626–630. See, also, PLANTS.
LIFE, ORGANIC,
common to plants and animals, p. 53, § 101 ; p. 280, § 449 *d*;—modified in each, p. 54, § 107 ; p. 88, § 185.
has no repose, p. 53, § 102.
necessary to animal life, p. 54, § 108, 117. See, also, PLANTS, ORGANIC LIFE, ORGANIC PROPERTIES, and VITAL PRINCIPLE.
its condition in the fœtus. See BLOODVESSELS.
LIGHT,
discoveries in, p. 90–92, § 188½ *d*.
applied to illustrate the philosophy of life, p. 46, § 74 ; p. 90–95, § 188½ *d*; p. 112–117, § 234 *c*–234 *f*; p. 328–331, § 500 *m*–500 *o*; p. 554, § 872 *a*; p. 556, § 872 *a*; p. 567, § 889 *k*; p. 671, § 903.
Light—*continued.*
a vital agent, p. 46, § 74 ; p. 90–95, § 188½ *d*; p. 134, § 293 ; p. 137, § 303 *e*; p. 164, § 350, No. 65 ; p. 281, § 450.
analogous to all other vital agents, p. 46, § 74 ; p. 90–95, § 188½ *d*; p. 281–283, § 450 *d*–451 *f*; p. 328–331, § 500 *m*–500 *o*; p. 671, § 903. See, also, ANALOGIES.
important in vital philosophy, p. 92–95, § 188½ *d*; p. 137, § 303 *e*.
its component parts established, p. 92, § 188½ *d*.
its visible, chemical, Tithonic, and phosphorogenic rays, p. 90, 92, § 188½ *d*.
its luminiferous rays act as a whole in ordinary vision, but not so those or the other rays upon inorganic compounds, p. 92–95, § 188½ *d*; p. 567, § 889 *k*.
sought by the leaves of plants in dark places, upon a principle of Design corresponding with the attraction of roots to appropriate means of nourishment, *ibid*, and p. 166, 167, § 350, Nos. 26½, 27, 77.
indispensable in vegetable life, p. 92–95, § 188½ *d*; p. 137, § 303 *e*.
chemical and vital theories of its action, *ibid.*
if the union of carbon into organic compounds by the leaf of plants be due to organic influences, then are the same influences the cause of the immediately antecedent decomposition of the carbonic acid gas ; and if, also, the roots of plants decompound the carbonic acid which they extract from the soil, and so allowed by chemists, it follows, farther, that light is not the decomposing agent for the *same* phenomenon in the leaf, p. 136, 137, § 303 *b–e*; p. 163–166, § 350, Nos. 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74, 75, 76, 77, 26½, 27, 28. See, also, MUCOUS TISSUE, in its relation to *carbon*
author's theory of *white* light, p. 94, § 188½ *d*; p. 566, 567, § 889 *k*.
its velocity, undulations, and mode of excitement, illustrative of the nervous power, p. 114, § 234 *e*.
rate of its velocity, and of its undulations, p. 114, § 234 *e*.
its modus operandi in physics unknown, p. 115, § 234 *e*, *f*.
its laws known, p. 115, § 234 *e*.
its undulations aid not our knowledge of its laws, p. 115, § 234 *e*.
develops the rudimentary eye, by its action upon irritability, p. 46, § 74 *a*.
comparison of its action upon irritability in producing organic results, and upon sensibility in the process of vision, embarrassing to chemis-

Light—*continued.*
try, p. 46, § 74 *a*; p. 92–95, § 188½ *d*; p. 281–283, § 450 *e*–451 *f*; p. 330, § 500 *n*.

Liver,
developed from the intestinal Canal, p. 41, § 65. See Assimilation.

Loss of Blood, Influences and Modus Operandi of, p. 690–777. See Bloodletting.

Lobelia,
preferable to tobacco in strangulated hernia, p. 717, § 960 *a*. See, also, Expectorants, and Therapeutics.

Lungs,
mucous tissue of, alone eliminates an effete matter from venous blood, p. 62, § 135 *a*; p. 229, § 418, 419; p. 274–278, § 447½.
experiments to Determine the Relation of their Functions to the Nervous System, p. 315.

Lymph. See Inflammation, and Bloodletting, General.

Lymphatics. See Absorption, Tissues, Structure, and Inflammation.

M.

Magnetism,
an imponderable substance. Why not the vital principle, p. 113, § 234 *c*; p. 115, § 134 *c*.
its existence and laws known by its effects, p. 113, § 234 *c*.
applied to illustrate the philosophy of life, p. 113, § 234 *c*. See, also, Galvanism, Gravitation, Light, and Imponderables.

Magnetism, Animal. See Animal Magnetism.

Mankind,
but one species of, proved by the sameness of reason and instinct in all, p. 123, § 241 *c*, *note*.
races of, p. 391–393.

Materia Medica,
objects of, p. 3, § 2.
the organic, composed of three or four elements, p. 25, § 47; p. 27, § 52.
each article of, has virtues peculiar to itself, p. 27, § 52; p. 417, § 650; p. 545, § 860.
its members often embrace two or more virtues, p. 555, § 872 *a*; p. 571, § 890 *b*; p. 597, § 892 *c*; p. 599, § 892 *d*.
redundant, yet the bad may have its uses, p. 556, § 872.
remedial effects of, can be known only from observation in diseased states of man, p. 122, § 240; p. 541, 542, § 854; p. 545, § 859.
Pereira's, the best, p. 676, § 904 *c*.
author's Arrangement of, p. 542, § 854 *c*; p. 564, § 889 *c*; p. 583, § 891 *a*; p. 634–646, § 892½ *b*–893 *d*; p. 683–689, § 905½.
nature of its relations to *Therapeutics*, p. 541, § 852 *a*; p. 662–665, § 895–901.

Materialism,
disproved, p. 16, § 14 *c*; p. 84–86, § 175 *c*–175 *d*. See, also, Vital Properties in the Elements of Matter, Generation Spontaneous, Design, and Nature Contradistinguished from its Author.

Materialism, Medical, p. 86, § 175 *d*; p. 95, § 189 *b*.

Matter,
author's proof from, of a Creator, p. 16, § 14 *c*. See, also, Design, Nature Contradistinguished from its Author, God and Nature Confounded, and Vital Properties in the Elements of Matter.
its nature unknown, p. 80, § 169 *a*; p. 117, § 234 *g*.
its properties immutable in *kind* but through some change in the arrangement of its compound or simple molecules, p. 99, § 191 *d*; p. 114, § 234 *d*; p. 120, § 237.
its final cause, p. 23–25, § 34–43, 46.

Mechanical Relations,
in organic beings, p. 59, § 129 *k*.

Medical Education and Practice in Europe and the United States,*
comparative view of, p. 13, § 5½ *a*; p. 28, § 53 *c*; p. 43, § 64; p. 50, § 83 *k*; p. 60, § 131; p. 86, § 175 *d*; p. 133, § 291; p. 136, § 303 *a*; p. 139, § 303⅔; p. 148, § 334; p. 149, § 338; p. 154, 155, § 149 *c*–*e*; p. 174–182, § 350½–350⅔ *f*; p. 185–187, § 350⅔ *kk*; p. 197–199, § 362–364; p. 202, § 376½; p. 219, § 408; p. 220, 221, § 409 *b*; p. 226, § 409 *j*; p. 233, § 427; p. 334, 335, § 433; p. 338, § 438 *b*–*d*; p. 239–247, § 440, Nos. 1–19; p. 274–278, § 447½; p. 433, § 676 *b*; p. 457, § 699 *c*; p. 458, § 701; p. 460–463, § 709, and *note*; p. 482, § 744; p. 484, 485, § 748, 749; p. 488, § 756 *a*; p. 515, § 819 *b*; p. 518, 519, § 823–825; p. 540, § 851 *a*; p. 573, § 890 *d*; p. 584, § 891 *c*; p. 603, § 892 *k*; p. 654, § 893 *n*; p. 690, § 906 *a*–*d*; p. 715–722, § 960 *a*–*d*; p. 760, § 1005 *k*; p. 762, 763, § 1006 *a*. See, also, British and

* "About *thirty* Medical Schools in the United States, in which there is probably an annual average of 4500 students, 1300 of whom are yearly graduated. (Population, 20,000,000.) In France, with a population of 35,000,000, there are but *three* Medical Schools, which graduate only about 700 annually!" — *Boston Medical and Surgical Journal, Dec.* 2, 1846, p. 365.

Medical Education—*continued.*
FOREIGN MEDICAL REVIEW, *in advocacy of Animal Magnetism, and the "Water Cure,"* Oct., 1846, p. 428–458; p. 475–485; and *Author's* INTRODUCTORY LECTURE ON THE IMPROVEMENT OF MEDICAL EDUCATION IN THE UNITED STATES, and MEDICAL AND PHYSIOLOGICAL COMMENTARIES, vol. i., p. 257–273, 283, 300, 305, 309, 327, 384–440, 511–515 *notes*, 626–632, 682–690, 699–712; vol. ii., p. 224–229, 324–327 *note*, 354–377, 700–815.

MEDICAL PROFESSION OF THE UNITED STATES, DEFENSE OF, p. 460–463, § 709, and *note* there.

MEDICAL SCIENCE, "THE PROGRESS OF," p. 13, § 5½ *a, b*. See, also, MEDICINE, MEDICAL EDUCATION, ORGANIC CHEMISTRY, and HUMORALISM.

MEDICINE,
philosophy of, p. 1, § 1.
the necessity of consistency in its principles and details, p. 1, § 1.
the work of observation, p. 3, § 2 *c*; p. 11, § 5¼ *e, f*.
its elevated nature, p. 122, § 240; p. 186, § 350¾ *kk*; p. 412, § 638. See, also, DESIGN.
its ground-work simple, p. 4, § 2 *d, e*; p. 40–49, § 65–80; p. 87, § 177–182; p. 88, § 185.
its details complex, p. 109, § 232; p. 120–122, § 237–240; p. 405–412, § 638.
its difficulties, p. 11, 12, § 5¾ *e*; p. 121, § 237; p. 383, § 584; p. 397, § 623; p. 545, § 859 *b*, and *references* there; p. 662–664, § 895–899. See, also, PHYSICIANS AND SURGEONS.
its branches, a cemented chain, p. 3, § 2 *d*; p. 131, § 285; p. 405–412, § 638.
the relations of its branches, *ibid.*
theories of, p. 5, § 4.
chemical, physiological, and chemico-physiological schools of, p. 6, 7, § 4½ *a–e*.
vitiated by Experiments under the disguise of "*Experimental Philosophy*," p. 11–14, § 5¼ *e*–6; p. 17–19, § 18 *b–e*; p. 26, § 48; p. 28, § 53 *c*; p. 50, § 83 *a, b*; p. 60, § 131; p. 132, 133, § 289–292; p. 148, § 334; p. 164–170, § 350, Nos. 23½, 28, 29, 31, 39, 44, 45; p. 175, 176, § 350½ *n, o*; p. 177–182, § 350¾ *f*, 350¾ *a–g*; p. 197–203, § 362–376½; p. 371, § 569 *b*; p. 434, § 676 *b*; p 457, § 699 *c*; p. 482, § 744; p. 484, 485, § 748, 749; p. 489, 490, § 757 *a*; p. 509, § 810; p. 515–519, § 819–825; p. 528, § 830 *a*–831; p. 541, 542, § 854 *bb*; p. 573, § 890 *d*; p. 603, 604, § 892 *k*; p. 711, § 952 *b*; p. 715–722, § 960

Medicine—*continued.*
a–d; p. 760, § 1005 *k*; p. 762, 763, § 1006 *a*; p. 765, § 1006 *g*.
its relationship to chemical and mechanical philosophy, p. 8, § 5; p. 11, 5¼ *c*; p. 202, 203, § 376½; p. 434, § 676 *b*.
contradistinguished from chemical and mechanical philosophy, p. 7, § 4½ *d*; p. 8, 9, § 5; p. 8, § 5; p. 10, § 5¼ *a*; p. 11, § 5¼ *c, e*; p. 14, § 6; p. 19, § 18 *e*; p. 21–36, § 20–62; p. 40–42, § 65, 66; p. 99–111, § 188*d*–233¾; p. 135–139, § 303–303¾; p. 149–203, § 337–376½; p. 234–279, § 433–448; p. 323–332, § 500; p. 362, § 530; p. 376–380, § 578; p. 383, § 584 *a*; p. 391, 392, § 602 *d*–606; p. 393, § 612; p. 397, § 623; p. 398, § 626; p. 401, § 631; p. 405–412, § 638; p. 662, 663, § 895, 896.
its relative condition in Europe and the United States. See MEDICAL EDUCATION.
its difficulties, intellectual nature, and usefulness to mankind, compared with *Surgery*. See PHYSICIANS AND SURGEONS.

MEDICINE, "SPECIALITIES" IN,
objections to, p. 721, 722, § 960 *c, d*.

MEDICINE AND SURGERY,
their comparative usefulness and difficulties, p. 614, § 892½ *d*. See, also, PHYSICIANS AND SURGEONS.

MEDICINES. See REMEDIES.

MEMBRANES. See TISSUES.

MENSTRUATION,
an excretory function, p. 62, § 135 *a*; p. 233, 234, § 428–432.
not important in organic life, p. 234, § 428.
designed for impregnation, p. 234, § 428.
its suspension, *per se*, of little importance to health, p. 234, § 432.
the influences of its suspension depend upon the cause. See EMMENAGOGUES, ERGOT, and UTERINE AGENTS.
its institution, and effects of. See YOUTH, p. 376–380.

MENTAL EMOTIONS, AND PASSIONS,
how they operate, p. 89, § 188 *a*; p. 95, § 188½ *d*; p. 107, § 227; p. 108, § 228 *b*; p. 109, § 230, 232; p. 111, § 233¾; p. 326–330, § 500 *f*–500 *n*; p. 670, § 902 *l*.
elect certain metor nerves, like the will and physical agents, p. 111, § 233¾; p. 113, § 243 *c*; p. 326–330, § 500 *f*–500 *n*.
designed for moral and physical good, p. 113, § 234 *c*.
morbific and curative, and analogous in their influences with physical causes

Mental Emotions, &c.—*continued*.
and with the will, p. 92–95, § 188½ *d;* p. 111, § 233¾; p. 113, § 234 *c;* p. 296, § 476 *c;* p. 326–330, § 500 *f*–500 *n;* p. 534, § 844; p. 670, § 902 *b*.
chemical theory of, p. 155, § 349 *e*. See MIND, and INSTINCT.
MESMERISM. See ANIMAL MAGNETISM.
METAPHYSICIANS,
regard the operations of the mind abstractedly from the brain, p. 123, § 241 *c*.
METASTASIS,
its fallacy, p. 653–656, § 893 *n*.
MICROSCOPE,
useless and deceptive in important organic inquiries, p. 50, § 83; p. 60, § 131; p. 143, § 320; p. 219, § 407 *b;* p. 342, § 515.
MIND, AND ITS PROPERTIES, p. 122–125.
not a product of secretion, *the only independent motive power*, and capable of being acted upon, p. 84, 85, § 175 *c*.
confounded with the chemical forces, p. 182, 183, § 350¾ *gg*. See, also, GOD AND NATURE, VITAL PROPERTIES IN THE ELEMENTS OF MATTER, and PROBLEMS.
its analogies with the vital principle, p. 84, § 175 *b;* p. 88, § 183, 184; p. 89, § 186; p. 98, § 191 *c;* p. 112–125, § 234 *c*–246.
its relation to the brain, p. 85, § 175 *c;* p. 98, § 191 *c;* p. 123–125, § 241–246; p. 281, § 451; p. 332, § 500 *p*. See, also, MENTAL EMOTIONS AND PASSIONS, and INSTINCT.
its morbid states, p. 98, § 191 *c*.
its individuality, p. 84, § 175; p. 122–125, § 241–246.
its "Plenipotentiaries" the Nervous Power, p. 77–79, § 167 *f*.
its advancement in successive generations, p. 206, § 376¾ *a;* p. 719, 720, § 960 *a*.
compared with instinct. See INSTINCT.
CHEMICAL THEORY OF, p. 155, § 349 *e*. See PROBLEMS.
MINERAL COMPOUNDS. See COMPOUNDS, MINERAL.
MINERALS,
their most natural state, elementary, p. 23, § 39.
their final cause, the existence and welfare of organic beings, p. 16, § 16; p. 23, § 34–36; p. 86, 87, § 176; p. 135–138, § 300–303½.
MINERAL KINGDOM,
independent of the animal, and vegetable, p. 15, § 9–14; p. 137, 138, § 303¼.
its final cause. See MINERALS.
MOBILITY,
a property of life common to animals and plants, p. 88, § 183, 184 *a*.

Mobility—*continued*.
a preferable term to *contractility*, p. 103, § 205 *b*.
the cause of motion in organic beings, p. 103, § 205–215; p. 107, § 226; p. 110, 111, § 233, 233¾; p. 284, § 455 *a;* p. 286, § 456, 457; p. 289, § 461½ *a;* p. 322–332, § 498–500. See, also, ABSORPTION, BLOOD-VESSELS, and POWERS WHICH CIRCULATE THE BLOOD.
distinct from *irritability*, p. 103, § 206; p. 110, § 233. See, also, IRRITABILITY.
demonstrable in plants, p. 103, § 207; p. 134, § 293; p. 286, § 456 *a;* p. 322, § 498 *c*.
occasions sensible and insensible motions, p. 104, § 213.
excited through *irritability*, p. 103, 104, § 208, 215; p. 107, § 226; p. 110, § 233.
dormant in the seed and ovum, p. 30, § 57; p. 56, § 123; p. 104, § 212.
modified in animal and organic life, p. 61, § 133 *b;* p. 62–68, § 135–155; p. 110, 111, § 233, 233¾; p. 295, § 475; p. 296, § 476 *c;* p. 314, § 488; p. 323–332, § 500. See MOTION.
MOLECULAR MOTION *versus* CATALYSIS, p. 226, § 409 *j*.
MORBID ANATOMY,
its practical and philosophical uses, p. 456–463, § 695–709.
MORBIFIC CAUSES,
philosophy of their action, p. 47–49, § 75–80; p. 55, § 117; p. 59, § 129 *h;* p. 61, § 133 *c;* p. 63, § 137; p. 65, § 142, 143; p. 67, 68, § 149–152; p. 69, § 156; p. 87, § 177–182; p. 89, § 188; p. 107–110, § 226–232; p. 111, § 233¾; p. 414, § 644, 645; p. 417, § 650; p. 421, 422, § 657; p. 423, § 659; p. 424, § 661; p. 425, § 664; p. 426, § 666; p. 662–665, § 895–901.
their difference from remedial agents, p. 542, § 854. See, also, REMEDIAL ACTION, VITAL HABIT, and THERAPEUTICS.
MORPHIA. See NARCOTICS, and THERAPEUTICS.
MORTIFICATION,
vital theory of, p. 447, § 736 *a–e*.
mechanical theory of, p. 447, § 736 *b*, *e;* p. 484, 485, § 748, 749.
chemical theory of, p. 175, § 350½ *m*.
MOTION,
indispensable to all organic beings, excepting in the state of the germ, p. 126–128. See, also, GERM.
destructive of mineral compounds, p. 21, § 24–26.
sensible and insensible, p. 103, § 207.
how produced through sympathetic sensibility, p. 101, § 201, 202; p.

Motion—*continued.*
104, § 209, 210; p. 282, § 451; p. 323–330, § 500. See, also, Laws of Sympathy.
insensible the most important, p. 104, § 214; p. 227, § 410, 411; p. 663, § 896. See, also, Capillaries.
voluntary, how produced, p. 88, § 188; p. 104, § 215; p. 110, § 233; p. 111, § 233¾; p. 127, § 259; p. 128, § 266; p. 134, § 293–295; p. 323–332, § 500.
spasmodic, readily induced in the voluntary muscles, and why, p. 284, § 455; p. 296, § 476 *c;* p. 324–328, § 500 *d–l;* p. 357, 358, § 526 *d;* p. 404, § 637.
how produced in organic life, p. 88, § 188; p. 110, § 233; p. 111, § 233¾.
independent of the nervous system, p. 104, § 215; p. 110, § 233; p. 127, § 259; p. 284–289, § 454–461½; p. 663, § 896. See, also, Experiments to determine the Laws of the Vital Functions, p. 295–321, and Laws of Sympathy, p. 335–362.
how produced through *irritability*, with or without the agency of the nervous power, p. 89, 90, § 188, 188½; p. 95, § 189; p. 98, § 191; p. 103, § 208; p. 107–111, § 226–233¾; p. 323–332, § 500; p. 356–358, § 526 *d;* p. 663, § 896.
voluntary and *involuntary*, their difference lies, mostly, in the nature of the stimuli, and partly in modifications of *mobility*, p. 102, § 201; p. 104, § 215; p. 107, § 227; p. 110, 111, § 233, 233¾; p. 296, § 476 *c;* p. 323–332, § 500; p. 357, 358, § 526 *d;* p. 663, § 896. See, also, Mobility, and Will.
the great intrinsic characteristic of the *organic* kingdom, *inertia* that of the *inorganic*, p. 21, § 24; p. 30, § 59; p. 86, 87, § 176.
interests us most, *ibid.*
chemical Theory of, oxydation of the blood and tissues, p. 158–162, § 350, Nos. 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 15, 16, 17; p. 208, § 283; p. 274, § 447½ *a.*
Motor Nerves. See Nerves.
Mucous Tissue,
proof from, by the *Author*, that the elimination of carbon from the blood is a vital process. Combine the direct facts and the analogies at p. 62, § 135 *a;* p. 201, § 374, 375; p. 229, § 419 *a*–419 *c.* See, also, Carbon, and Light, in its relation to *carbonic acid.*
modified in its organic properties in different parts of the body, and as traversing different parts, shown by

Mucous Tissue—*continued.*
its natural products, and by the effects of natural, morbific, and remedial agents, p. 62, 63, § 135–137; p. 67, 68, § 149–152. See, also, Remedial Action, and Therapeutics.
Mucus,
the laws which govern its formation. See Secretion, p. 217–227.
its morbid states, p. 452. See, also, Inflammation.
Muscles of Voluntary Motion,
experiments to determine the Principle on which their Motion depends, and the Relation they bear to the Nervous System, p. 310, § 486.
comparative effects of Stimuli upon, and upon the Heart, when applied to the Brain and Spinal Cord, p. 311–315, § 487–489. See, also, Motion, and Will.

N.

Narcotics, p. 583–590, § 891; p. 715–721, § 960 *a*, *b*.
an unimportant class of agents compared with many curative means, *ibid.*
their preference as means of relieving, or preventing pain, to agents which strike at disease and grapple with Death, evinces a want of proper medical philosophy, and of a proper reference to the best interests of mankind, *ibid.* See, also, Pain.
affect the nervous power so as to render it more or less insusceptible to the action of other agents, p. 567, § 889 *k;* p. 672, § 904 *a*, and *ibid.* See, also, Nervous Power.
Nature,
its foundation simple, its phenomena complex, p. 4, § 2 *e;* p. 662–664, § 895–899. See, also, Adaptation and Design.
contradistinguished from Creative Power, p. 16, § 14 *c;* p. 25, § 43; p. 46, § 74 *a;* p. 81, § 170 *a;* p. 83, § 172; p. 86, § 175 *d;* p. 124, § 241; p. 227, § 411; p. 317, § 493 *a;* p. 376, § 578 *b;* p. 393, § 612.
confounded with Creative Power, p. 40, § 64 *h;* p. 46, § 74 *a;* p. 76, § 167 *b;* p. 86, § 175 *d;* p. 178–189, § 350¾ *a*–350¾ *m.*
the Interpreter of its Author, p. 186, § 350¾ *kk;* p. 227, § 411. See, also, Design.
man her interpreter, p. 5, § 4 *a.*
the Conservator of Organic Beings; see Vis Medicatrix Naturæ, and Vital Principle.
the great fountain of rational enjoyment, and the only foundation of philosophy; *ut supra.*

Nature, Kingdoms of, p. 15, § 7, &c.
the organic, and inorganic, have, respectively, their peculiar properties and laws, p. 4, § 3; p. 14, § 6; p. 20–27, § 19–51; p. 34–36, § 62.
phenomena of the organic more various than of the inorganic, p. 4, § 3; p. 14, § 6; p. 117, § 234 *g;* p. 331, § 500 *o*.
our knowledge of each depends upon the nature or variety of the phenomena, p. 4, § 3; p. 80, § 169; p. 111–121, § 234–237.
not mutually dependent, p. 15, § 9–14; p. 16, § 16, 17; p. 23, § 35, 37; p. 24, § 41, 42; p. 25, § 43; p. 135–139, § 300–303½.
creation of the vegetable and animal reversed, p. 135–138, § 303, 303½.
motion the great sensible attribute of the constitution of the organic, *vis inertiæ* that of the inorganic, p. 21, § 24; p. 30, § 59; p. 86, 87, § 176.
simple in their foundation, p. 4, § 2 *e;* p. 331, § 500 *o;* p. 662–664, § 895–899.

Nerves,
of little importance in fœtal life, p. 43, § 69; p. 286, § 456; p. 289, § 461½ *a*.
their early development in the fœtus, like that of the liver, kidneys, and organs of sense, &c., consistent with their dormant state, in the great plan of Organic Design, p. 42, 43, § 67–70; p. 284, § 455 *a, b;* p. 286, § 456; p. 289, § 461½ *a;* p. 342–353, § 516–524.
mostly important to the sphincter muscles in the life of the fœtus, p. 339, § 514 *f, g*.
not the source of motions or of any organic result, p. 43, § 69; p. 46, § 74; p. 89, § 188 *c;* p. 110, § 233; p. 389, § 461; p. 296, 297, § 476½ *b;* p. 317, 318, § 493; p. 324, § 500 *c, d;* p. 475, § 733 *h;* p. 483, § 746 *c*. See, also, Capillary Action, and Mobility.
an important distinction between their trunks and expanded extremities, p. 280, § 450 *b;* p. 521, § 826 *d;* p. p. 585, § 891 *e*.
their functions neglected, or perverted, or ill considered, p. 112, § 234 *b;* p. 155, § 349 *e;* p. 162, 163, § 350, Nos. 18, 19, 20; p. 177, § 350¾ *e;* p. 193, § 356 *a;* p. 283, § 452 *b;* p. 296, § 476½ *b;* p. 317, 318, § 493. See, also, Humoralism.
how far concerned in morbid processes, p. 285, 286, § 455, 456; p. 332, § 502 *a;* p. 483, § 746 *c*. See, also, Experiments to determine the Laws of the Vital Functions.

Nerves, the Different Orders of, p. 290–292. See, also, Cerebro-Spinal and Ganglionic Systems, and Sympathetic Nerve.

Nerves, Motor,
their functions and laws of action, p. 102, § 202; p. 106, § 224; p. 110, § 233; p. 111, § 233¾; p. 292, § 471; p. 326, § 500 *g;* p. 330, § 500 *n;* p. 335–353, § 512–524; p. 521, § 826 *d;* p. 746, § 990½ *b*.

Nerves, Sensitive,
their functions and laws of action, p. 101–103, § 201–204; p. 281, § 450 *e;* p. 292, § 472; p. 326, § 500 *g;* p. 330, § 500 *n;* p. 335–353, § 512–524; p. 521, § 826 *d*.
of true sensation, mostly cerebro-spinal, p. 101, 102, § 201; p. 284, § 455 *a*.
of sympathetic sensation, mostly the ganglionic and pneumogastric, p. 101, 102, § 201; p. 109, § 230; p. 284, § 455 *b;* p. 746, § 990½ *b*.

Nervous Power,
a property of the vital principle, and peculiar to animals, p. 88, § 183, 184; p. 110, § 232.
affords a demonstrative proof of the existence of a vital principle, and of its own existence as a property of that principle, and that it operates beyond the surface of organs, p. 42, § 67; p. 746, § 990½ *b*.
enters largely, or its organs, into the physical doctrines of life, p. 162, 163, § 350, Nos. 18, 18½, 19; p. 111, 112, § 234 *a;* p. 317, 318, § 493; p. 475, § 733 *h*.
commonly regarded as the electric or galvanic fluid, p. 88, § 184 *b*.
its action upon irritability, another property, not more remarkable than the control which the will exercises over other properties of the mind and the passions, p. 88, § 184 *b*.
generated especially by the brain and spinal cord, but also by the ganglia of the sympathetic, p. 321, § 497; p. 323, § 499; p. 334, § 507; p. 342–346, § 515, 516; p. 349, § 520; p. 353, § 524 *d*, Nos. 4–7.
the philosophy of its operation, and its application to pathology and therapeutics, how far expounded by the Author, p. 106, § 222; p. 111, § 234 *a;* p. 162, 163, § 350, Nos. 18, 19; p. 297, § 476½ *b;* p. 317, 318, § 493; p. 320, § 494 *dd;* p. 342, § 514½ *b;* p. 515, § 819 *b;* p. 746, § 990½ *b;* and throughout the philosophy of Remedial and Morbific Action, and of the Operation of Loss of Blood.
its nature, useless to be known, p. 60, § 131, *Milton;* p. 88, § 184 *b;* p. 117, § 234 *g*.

Nervous Power—*continued.*
as with Light and Magnetism, not *in transitu*, p. 115, § 234 *e*.
like light and electricity, brought into operation by exciting causes, p. 115, § 234 *e*.
acts upon *irritability*, p. 88, § 184 *b*; p. 89, § 188; p. 107, § 226; p. 110, § 233; p. 323–332, § 500. See, also, Remedial Action.
how developed, p. 89, § 188; p. 107, § 225–227; p. 114, § 234 *e*; p. 323–332, § 500. Also, Remedial Action.
excited directly and indirectly, p. 107, § 227; p. 323–332, § 500. Also, Experiments to determine the Laws of the Vital Functions, and Remedial Action.
developed by agents applied to the brain, spinal cord, and nerves, by the will and passions, by internal physical causes, by external agents acting upon all parts, and by disease of all parts, p. 107–111, § 227–233¾; p. 333, § 503; p. 334, § 507; p. 349, § 520; p. 356–358, § 526 *d*; p. 706, 707, § 947, and *ut supra*.
superadded to the animal kingdom, and why, p. 54, 55, § 107–117; p. 106, § 223; p. 110, § 232; p. 284, 285, § 454, 455; p. 475, § 733 *h*.
operates in animal and organic life, p. 106, § 223; p. 110, § 233; p. 111, § 233¾; p. 323–332, § 500; p. 483, § 746 *c*.
most important in the organic life of animals, yet its greatest final cause is relative to animal life, p. 55, § 113; p. 106, § 223; p. 127, § 259; p. 262, § 446 *a*; p. 284, 285, § 454, 455.
in constant operation upon various parts, p. 106, § 223; p. 111, § 233¾; p. 113, § 234 *c*; p. 115, § 234 *e*; p. 335–341, § 512–514.
maintains harmonious action among the viscera of organic life, p. 55, § 113; p. 106, § 223; p. 108, § 228 *a*; p. 110, § 232; p. 284, § 455.
when most obvious in its effect, in animal and organic life, p. 324, § 500 *c*, *d*; p. 332, § 501; p. 662, 663, § 896.
its important natural action mostly limited to compound organs, and to certain muscles in animal life, affecting comparatively little the capillary vessels excepting as roused into action by transient causes, but capable of exciting the most powerful influences upon them. See *references above*, and Nerves and Capillaries.
but little operative in fœtal life, p. 43, § 69. See, also, Nerves, and Capillaries.
operates through motor nerves, p. 106, § 224; p. 290–292, § 462–471; p. 330, § 500 *n*.
indispensable to voluntary motion in all animals, p. 104, § 215; p. 110, § 233; p. 127, § 259, 260.
necessary to the action of the sphincter muscles and those of respiration, p. 325–327, § 500 *e–i*; p. 338, 339, § 514 *f*, *g*.
may respond through the same motor nerves to impressions transmitted through various sensitive nerves, p. 327, § 500 *i*.
indispensable to reflected motion, p. 102, § 201; p. 107–111, § 227–233¾; p. 323–332, § 500; p. 404, § 637.
does not involve sensation, p. 106, § 223.
implanted in the brain, spinal cord, ganglia, and nerves, or in the ganglionic system of inferior animals, p. 106, § 224; p. 115, § 234 *e*; p. 334, § 507, and as *above*.
acted upon and altered in kind, &c., p. 107, § 225, 226. See, also, Remedial Action.
a vital agent, p. 107, § 226, 227; p. 323–332, § 500; p. 359, § 526 *d*; p. 483, § 746.
its operation and results analogous to other vital agents, p. 107, 108, § 227, 228; p. 114–118, § 334 *d–k*; p. 331, § 500 *o*; p. 483, § 746 *c*; p. 706–708, § 947, 949. See, also, Analogies.
excited through sympathetic sensibility, p. 108, § 227; p. 116, § 234 *f*; p. 281–283, § 450 *e*, 451.
partakes of the virtues of the exciting causes, under the influence of its own nature, p. 108–110, § 227–232; p. 333, § 503; p. 647, § 893 *e*.
its modus operandi, p. 107–111, § 227–233¾; p. 115, § 234 *e*; p. 125, § 245; p. 296, § 476 *c*; p. 323–332, § 500; p. 334, § 509, 510; p. 357, § 526 *d*; p. 663, § 896; p. 703–711, § 940–952. See, also, Remedial Action, and Remote Causes of Disease.
exquisitely susceptible, p. 11, § 5¼ *e*; p. 108, 110, § 228, 232; p. 323–332, § 500, 501; p. 357, § 526 *d*; p. 706, 707, § 947.
operates according to the nature of the existing and modifying causes, p. 107, 109, 111, § 227, 230, 233¾; p. 296, § 476 *c*; p. 301, 302, § 480, 481; p. 305, § 482; p. 309–314, § 484–489; p. 323–332, § 500; p. 334, § 509; p. 405–412, § 638; p. 662, 663, § 896; p. 706, 707, § 947. See, also, Remedial Action.
an important law of, in relation to organic life, and as distinguished from the corresponding law in animal life, p. 312, § 487 *g*.

Nervous Power—*continued.*
its effects in proportion to the suddenness, as well as violence of its action, p. 11, § 5¼ *e;* p. 298, § 476½ *h;* p. 300, § 479; p. 304, § 481 *g;* p. 319, 320, § 494; p. 334, 335, § 509–511; p. 523, 524, § 527 *d;* p. 525, § 828 *b;* p. 662, 663, § 896; p. 703–711, § 940–952; p. 726, § 961.
powerfully operative in inducing and removing syncope, p. 304, 305, § 481 *g, h, Exp.* 18; p. 663, § 896; p. 703–709, § 940–951; p. 726, § 961.
its influences, natural, morbific, or remedial, p. 106, § 222, 223; p. 107–110, § 226–232; p. 284–287, § 454–458; p. 331, § 500 *o;* p. 483, § 746 *c;* p. 662–665, § 896–901. See, also, Remedial Action.
its relative effect when developed by disease of the nervous system, and when by other causes acting upon other parts, p. 334, § 508, 509; p. 356–358, § 526 *d;* p. 592, § 892½. See, also, Remote Causes of Disease, and Remedial Action.
its modifications illustrated by the modifications of electricity, polarized light, &c., p. 79, § 168; and *ut supra.*
its rapidity of action illustrated by the motions of light, &c., p. 114, § 234 *e;* p. 330, § 500 *n.*
adapted to the various exigencies of life, p. 108, § 228; p. 127, § 259; and *as above.*
influenced by slight variations in the intensity, or nature, of the operating causes, and by the precise part upon which they operate, p. 108–110, § 228–232; p. 323–332, § 500; p. 671, 672, § 904 *a.* Also, Remedial Action.
how affected by disease, p. 109, § 229; p. 662–664, § 895–900; and *as above.*
the cause of consecutive diseases, p. 109, § 229; p. 285, § 455; p. 339, § 514 *h.* See, also, Pathological Cause, Remote Causes, Remedial Action, &c.
its connection with the Law of Adaptation, p. 539, § 848.
operates on the organic constitution of the brain and nervous system, as upon other parts, p. 109, § 230; p. 334, § 509.
operates, however, but little as a morbific cause upon the nervous tissue, p. 334, § 508; p. 356–358, § 526 *d.*
mutable in its nature like the organic properties, p. 108–110, § 227–232. See Vital Properties, *their mutability,* and Remedial Action.
its mutability, like that of the organic properties, a main foundation of disease and its cure, p. 333, § 503, See, also, *partakes of the virtues,* &c., as above, and Vital Properties, &c.

Nervous Power—*continued.*
does not generate motion, p. 110, § 233; p. 127, § 259–261; p. 296, § 476½ *b;* p. 331, § 500 *o;* p. 663, § 896. See, also, Experiments to determine the Laws of the Vital Functions.
maintains the balance of functions, p. 110, § 232; p. 230, 231, § 422; p. 284, 285, § 455; p. 663, § 896.
in connection with the will, a remote cause of voluntary motion, p. 110, § 233; p. 111, § 233¾; p. 113, § 234 *c;* p. 284, § 455 *a;* p. 288, § 459 *d, e;* p. 296, § 476 *c;* p. 313, § 487 *gg, h;* p. 314, § 488, 488½; p. 324–332, § 500 *c;* p. 357, 358, § 526 *d;* p. 370, § 569 *a.*
its prolonged operation, natural, morbific, and remedial, p. 110, 111, § 232, 233½; p. 285–287, § 455–458; p. 333, § 506; p. 339, § 514 *g;* p. 344, 345, § 516 *d,* No. 6; p. 707, § 949. See, also, Remedial Action, and Alteratives.
elects special motor nerves, in animal and organic life, without apparent reference to anatomical arrangement, p. 111, § 233¾; p. 113, § 234 *c;* p. 327, 328, § 500 *k.*
its law of election adapted to the will, remedial agents, &c., p. 111, § 233¾; p. 287, § 458; p. 328, § 500 *l, m.*
rendered insusceptible of development by the will in paralysis, but susceptible to other causes, p. 296, § 476 *c;* p. 326–332, § 500 *f–p.* See, also, Narcotics.
rendered permanently stimulant to the organs of circulation by local inflammation, which thus influences the effects of loss of blood, p. 354, 355, § 526 *a;* p. 732–736, § 971–980.
depressant or excitant in phlebitis and venous congestion, p. 503, 504, § 794–798; p. 507–510, § 806–816; p. 724–732, § 961–970; p. 735, 736, § 978.
peculiarly modified in delirium a potu, mania, hydrophobia, &c., p. 734, § 975 *c,* 976 *a, b.*
especially excitant in cerebral inflammation and cerebral congestion, and according, also, to the nature of other tissues, and the kind of inflammation, p. 61, § 134; p. 64, § 140; p. 67, § 150, 151; p. 70–73, *tables;* p. 733–736, § 974–980.
variously modified in spasmodic and apoplectic affections, p. 356–358, § 526 *d;* p. 590–593, § 891½; p. 741–747, § 990–990½.

Nervous Power—*continued.*
how productive of motion after apparent death, and in decapitated animals, p. 338, § 514 *d;* p. 357, 358, § 526 *d;* p. 404, § 637.
developed by narcotics with such intensity, permanency, and organic influences, as to be more or less insusceptible to other agents. See Narcotics.
is morbific or curative, according to its modifications, p. 107–111, § 226–233¾; p. 336, § 514 *b;* p. 672, § 904 *a.* See, also, Remedial Action.
its development by Narcotics counteracted by pain, &c., p. 587–590, § 891.
its preternatural influences reach the internate organization of parts, readily, slightly, and profoundly, p. 109, § 230, 231; p. 230, § 422; p. 286, § 455; p. 334, § 508, 509; p. 335–341, § 512–514; p. 354, 355, § 526 *a;* p. 662, 663, § 896; p. 724–726, § 961 *a–e;* p. 732–736, § 971–980.
always operative upon muscles of mixed motion, and the exciting cause, p. 325, § 500 *e;* p. 339, § 514 *f, g.*
always inoperative upon the voluntary muscles, excepting when the will operates, p. 110, § 233.
illustrated by the "imponderables," p. 79, § 168; p. 113–121, § 234 *c*–237; p. 330, § 500 *n.*
spurious hypotheses of, p. 111, 112, § 234; p. 317, 318, § 493.
illustrative of stupendous Design, p. 106–111, § 223–233¾; p. 125, § 246; p. 284, § 484; p. 287, § 458; p. 323–332, § 499, 500; p. 662, 663, § 896.
its agency in the production of animal heat, p. 262–264, § 446; p. 663, § 896.
its instrumentality in animal heat analogous to its connection with all other products of living beings, p. 54, 55, § 109 *b,* 113; p. 262, 263, § 446; p. 483, § 746 *c;* p. 662, 663, § 896.
a knowledge, abstractedly, of its operation in health, of little practical importance, but of the greatest moment in disease; *ut supra.*
hitherto not applied, in any intelligible sense, to the explanation of the laws of sympathy, however those laws may be known, or to any natural results, while it is totally obscured in the philosophy of disease, by the chemical and physical doctrines, p. 106, § 222 *b;* p. 264, § 447 *c;* p. 283, § 451 *f;* p. 317, 318, § 493; p. 320, § 494 *dd;* p. 329, § 500 *n;* p. 342, § 514½ *b;* p. 362, § 530; p. 484, 485, § 748, 749; p 515–518, § 819 *b*–824; p. 661, § 894 *a;* p. 691, § 906 *g,* 909. See, also, Organic Chemistry, Capillary Action, and Remedial Action.
shown, by experiment, that syncope does not depend upon its failure to affect the heart, &c., p. 305, § 481 *h;* p. 706, 707, § 947, 948.
exerts a certain influence, as a vital stimulus, upon the functions and products of animals, p. 262–268, § 446–447 *d;* 483, 484, § 746 *c.*
presents a problem for *Chemistry,* p. 281, § 450 *e;* p. 330, § 500 *n.*
its functions, the Poetry of Nature; *ut supra.*

Nervous Systems, General Uses of, p. 284–290.

Nervous Tissues. See Tissues, and Structure.
not much subject to disease, p. 356–358, § 526 *d.*

Nitrogen,
a remarkable element of organic beings, p. 34–36.
a main cause of putrefaction and fermentation, p. 34, § 62.
abounds in animals, p. 34, § 62 *a, f.*
occurs in most parts of plants, p. 35, § 62 *f, note.*
a principle of dissolution, p. 34, § 62.
shown by the Author to prove a vital principle, p. 34–36, § 62.
wanting, naturally, in inorganic compounds, p. 34, § 62 *d, g.*
feebly compatible with chemical compounds, p. 34, 35, § 62 *d–h.*
not united with oxygen in the atmosphere, p. 34, § 62 *e.*
most indifferent of all the elements, p. 34, § 62 *d.*
maintains its connections in living organic compounds equally with the other elements, p. 35, § 62 *f.*
occasions transformations in dead organic and certain inorganic compounds by the contact of water, p. 35, § 62 *g.*
in compounds of sudden transformation, heat, or mechanical violence, is the predisposing, and water a retarding, cause.
occasions the ready explosion of fulminating compounds, p. 35, § 62 *e.*
another illustration in *gun-cotton,* &c.
one of its obvious final causes in organic beings is their ultimate dissolution; and this explains the philosophy of Tiedemann's statement, p. 28, 29, § 54 *a;* p. 36, § 62 *k.*
Author's proof from, of the creation of plants before animals, and against the speculatists, p. 136–138, § 303, 303½.

Nitrogenized Vegetable Food,
its uses in Chemistry, p. 17–19, § 18;

Nitrogenized Vegetable Food—*continued.*
p. 219–222, § 409 *a, b.* See, also, Protein.

Numerical Method and Organic Chemistry,
their parallel, p. 762, 763, § 1006 *a.*
alike necessary "Instruments" in Medicine, p. 161, § 350, No. 14, and as above.

Nutrition,
laws of, p. 40–45, § 65–73; p. 217–227, § 400–411.
requires the blood, or sap, as a universal stimulus, while in each part it is commonly promoted by specific stimuli, p. 46, § 74 *a;* p. 62, 63, § 136, 137.
theory of, in organic chemistry, p. 180, 181, § 350¾ *e.*
the globules of blood take no part in, p. 99, § 192; p. 255, § 441 *f;* p. 275, § 447½ *b;* p. 483, § 746 *a.*

Nutrition and Waste,
ends of organic life, p. 21, § 20, 27; p. 34, § 62 *b;* p. 53, § 104; p. 129, § 273. See, also, Absorbents.

Nux Vomica. See Aconite, &c.

O.

Oblivion,
Error its victim, *Truth* its vanquisher, p. 203–207, § 376½, 376¾ *a;* p. 462, *note;* p. 690, § 906 *f;* p. 755, § 1004 *b.*

Observation,
the importance of *minute* and *accurate,* in all physiological and medical inquiries, p. 1, 2, § 1; p. 3, 4, § 2 *d, e;* p. 10–12, § 5¼; p. 14, § 6; p. 16, § 14 *c;* p. 34–49, § 62–81; p. 61–73, § 133–163; p. 86, § 175 *d;* p. 92–96, § 188½ *d*–189 *c;* p. 99, § 192; p. 101, 102, § 201, 202; p. 106–122, § 222–240; p. 127, 128, § 261–266; p. 132, 133, § 289–291; p. 139, § 303¾; p. 143–146, § 322–326; p. 152, 153, § § 345–349 *a;* p. 154, 155, § 349 *c–e;* p. 157–182, § 350–350¾ *g;* p. 189, 190, § 350¾ *n;* p. 197, § 362; p. 200, 201, § 366–375; p. 208–217, § 383–399; p. 220–227, § 409–411; *and so on.*

Oil, Castor,
the introduction of, and of aloes and rhubarb, among the group of *Alteratives* in the Author's *Arrangement of the Materia Medica,* indicative of their special influence in small and repeated doses, p. 557, § 873 *b;* p. p. 567–569, § 889 *l–mm;* p. 571, 572, § 890 *b;* p. 636–642, § 892⅘ *d–i;* p. 687, § 905½ *c.* See, also, Alteratives.
author's opinion that it exerts a peculiar alterative action upon the liver, in morbid states of that organ, *ibid.*

Old Age,
its physiological and moral characteristics, p. 282, 283, § 581. See, also, Death.

Opinions,
not their *Authors,* the subjects of criticism. See Authors.
their want of independence, and arbitrary nature, characteristic of the age, p. 155, § 349 *d;* p. 174, § 350¼; p. 176, § 350½ *q;* p. 202, § 376½; p. 203–207, § 376¾ *a;* p. 235, § 433; p. 719, § 960 *a;* p. 762, 763, § 1006 *a.*
more independence of, in the United States than in Europe, and why, p. 460, § 709, and *note.* Also, Medical and Physiological Commentaries, vol. i., p. 327; vol. ii., p. 663–672.
when false, can not endure, p. 174, § 350¼; p. 202–207, § 376½, 376¾ *a.*

Opium,
possesses a factitious reputation as a curative agent, p. 584, § 891 *c;* p. 718, 719, § 960 *a.* See, also, Narcotics, Antispasmodics, Therapeutics, and Remedial Action.
its uses mostly limited to subduing pain in the absence of acute inflammation, moderating irritability, procuring sleep, and restraining diarrhœa, p. 583–590, § 891.
never to be employed for the relief of pain when it may aggravate disease, p. 587, 588, § 891 *k–m.*
curative, only by allaying irritability, and by thus preventing the deleterious action of exciting causes, or the unfavorable action of cathartics, and other irritating remedies, and thus promoting their favorable action, or by calming restlessness, and procuring sleep, and thus giving a favorable determination to the whole intervention of art, or to otherwise unaided Nature, p. 554, § 871, 872 *a;* p. 561, § 888 *b;* p. 585–590, § 891 *f–s;* but for these purposes is often inferior to cicuta, or hyoscyamus, especially where their frequent repetitions are useful, as in chronic irritability of the stomach, irritable tumors and ulcers, cases of phthisis attended by constipation, &c., and where cicuta, upon the ground of its sedative effect, has acquired, in some of the cases, the reputation of possessing positive virtues of an alterative nature, *ibid.*
removes diarrhœa by quieting intestinal irritability, while hyoscyamus will not exert that effect upon the intestinal mucous tissue in the same morbid state, p. 61–63, § 134–137; p. 65, § 143 *a, c;* p. 67, § 149–151; p. 73, § 163; p. 417, § 650; p. 427, §

Opium—*continued.*
668–670; p. 428, § 674 *a;* p. 430–433, § 675, 676 *a;* p. 543, § 856; p. 553–557, § 870–874; p. 561, § 888 *b;* p. 566, 567, § 889 *k;* p. 570, § 889 *n;* p. 571, 572, § 890 *b;* p. 575, 576, § 890 *k, l;* p. 577, 578, § 890 *o;* p. 583–590, § 891 *a–s;* p. 592, 593, § 891½ *k;* p. 718, § 960 *a.*

ORGANIC ANALYSIS,
difficult in its *elementary* aspect, p. 16, § 15; p. 18, § 18 *d.*
proximate, hypothetical, p. 14, § 6; p. 27–29, § 53; p. 221, 222, § 409 *b;* p. 228, § 417 *a.* See, also, PROTEIN.
its artificial transformations, p. 28, § 53; p. 228, § 417 *a.*
elementary, the legitimate objects of, in respect to science, p. 202, 203, § 376½.

ORGANIC BEINGS,
their general structure, p. 20, § 19; p. 50–61, § 83–133.
their composition, p. 15, § 12; p. 23–49, § 38–80.
how distinguished from minerals, p. 15–22, § 7–30; p. 23–49, § 38–80; p. 112–125, § 234–246; p. 157–173, § 350.
their peculiar properties, p. 73–125, § 164–246.
their peculiar functions, p. 125–372, § 247–569.
their relations to external objects, p. 398–400, § 626–630.
generate motion, p. 21, § 24; p. 31, § 59; p. 89, § 188 *a;* p. 345, 346, § 516 *d,* No. 7.
their waste and renewal, p. 21, § 27; p. 53, § 104; p. 129, § 273; p. 217, § 401 *b.*
their seventeen elements, p. 23, § 34, 35; p. 225, § 409.
their four principal elements, p. 23, § 37; p. 33, § 61, 62.
how their elements combine, p. 23, § 38, 39; p. 26, § 48, 49; p. 30–32, § 58, 59.
the vital power combines their elements, p. 30, § 58, 59; p. 36–47, § 63–74.
remarkable contrast in the number of their compounds and those of the globe, p. 24, 25, § 41, 46; p. 227, § 411.
their *vis vitæ* succeeded by *vis inertiæ,* p. 30, 31, § 59.
nitrogen gas, a remarkable element of, p. 34–36, § 62.
a knowledge and just appreciation of their properties, functions, and laws, indispensable in medicine, p. 4, 5, § 3, 4; p. 14, § 6.
why their general laws are determined, p. 14, § 6.

ORGANIC CHEMISTRY,
the extent of its power, p. 8, § 5; p. 14, § 6; p. 15, § 14 *b;* p. 16, § 15 p. 18, § 18; p. 24, § 42; p. 25, § 44, p. 27–29, § 53, 54; p. 29, § 54 *b;* p. 161, § 350, No. 59.
contradistinguished from Physiology and Medical Philosophy, p. 7, § 4½ *d;* p. 8, § 5; p. 10, § 5¼ *a;* p. 11, § 5¼ *c;* p. 14, § 6; p. 19, § 18 *e;* p. 21–36, § 20–62; p. 40–42, § 65, 66; p. 92–111, § 188½ *d*–233¾; p. 135–139, § 303–303¾; p. 149–203, § 337–376½; p. 234–279, § 433–448; p. 323–332, § 500; p. 362, § 530; p. 376–380, § 578; p. 383, § 584 *a;* p. 391, 392, § 602 *d*–606; p. 393, § 612; p. 397, § 623; p. 398, § 626; p. 401, § 631, *and so on.*
school of, p. 6, § 4½ *b.*
declining, p. 6, 7, § 4½ *b;* p. 203, § 376½.
inapplicable to medicine, p. 8, 9, § 5; p. 13, § 5½ *b;* p. 434, § 676 *b.*
its foundation, p. 10, § 5¼ *a, c;* p. 13, § 5½ *a;* p. 154, § 349 *c;* p. 155, § 349 *e;* p. 156, § 350, *mottoes;* p. 182, § 350¾ *g;* p. 197, § 362; p. 202, § 376½; p. 221, § 409 *b;* p. 235, § 433; p. 238, § 438; p. 239–248, § 440–441 *b;* p. 274–278, § 447½; p. 456, § 698; p. 519, § 824 *a.*
its promises of usefulness, p. 8, 9, § 5; p. 12, § 5½ *a.*
extent of its objects, p. 197, § 362.
points out the means of sustenance, p. 17–20, § 18 *b–c;* p. 156, § 350, *motto d;* p. 235, § 433.
may indicate the food for plants, p. 20, § 18 *e.*
applied to physiology, p. 7, § 4½ *b;* p. 13, § 5½; p. 14, § 6; p. 19, § 18 *e;* p. 29, § 54; p. 38–40, § 64 *e–k;* p. 152–203, § 345–376½; p. 226, § 409 *j;* p. 234–248, § 433–441; p. 274–278, § 447½.
its summary exhibition by Mülder, p. 180–183, § 350¾ *e–gg;* p. 189, 190, § 350¾ *n.*
its own statement of its ability and objects, p. 18, § 18 *c;* p. 161, § 350, No. 59; and how far observed, p. 157–178, § 350–350¾; p. 197, § 362; p. 202, § 376½.
its moral and religious tendencies. See LIFE.
the judgment of posterity upon, p. 9, § 5; p. 203, § 376½; p. 434, § 676 *b;* p. 762, § 1006 *a.*
how far substituted for medical philosophy, p. 8, § 5; p. 13, § 5½ *b;* p. 174–178, § 350½–350¾; p. 197, § 362; p. 202, 203, § 376½; p. 234, 235, § 433; p. 456, § 698; p. 515, § 819 *b.*
how far tolerant, p. 13, § 5½ *a;* p. 156, § 350, *mottoes, a, b, c, d, e;* p. 185, § 350¾ *kk;* p. 515, § 819 *b.*

Organic Chemistry—*continued.*
causes of its success, p. 11, § 5¼ *c;* p. 17, § 18 *c;* p. 133, § 292; p. 154, 155, § 349 *c, d;* p. 202, § 376½; p. 234, 235, § 433; p. 515, § 819 *b.* See, also, ANALOGIES, FALSE.
its recommendations, p. 6, 7, § 4½ *b, d;* p. 8, 9, § 5; p. 11, § 5¼ *c;* p. 13, § 5½ *b;* p. 14, § 6; p. 17, § 18 *c;* p. 19, § 18 *e;* p. 26, § 48, 49; p. 28, § 53 *c;* p. 30–32, § 59; p. 36, § 62 *i;* p. 38–40, § 64 *e–h;* p. 43, § 67; p. 85, § 175 *c;* p. 132–134, § 289–293; p. 136–139, § 303–303½; p. 152–192, § 345–352; p. 197, § 362; p. 199, § 364½; p. 202, 203, § 376, 376½; p. 220–222, § 409; p. 226, § 409 *j;* p. 234–260, § 433–445; p. 274–279, § 447½–448; p. 434, § 676 *b;* p. 456, § 698; p. 515, § 819 *b;* p. 519, § 824 *a;* p. 763, § 1006 *a.*
the Author's Motives for investigating its merits, p. 7, § 4½ *b, d;* p. 8, § 5; p. 13, § 5½ *a;* p. 148, § 335; p. 154, 155, § 349; p. 156, § 350, *mottoes, a, b, c, d, e;* p. 173–178, § 350¼–350¾; p. 191, § 351; p. 197, § 362; p. 202, § 376½; p. 234, § 433; p. 239, § 438 *d;* p. 241, § 440 *b;* p. 254, § 441 *e;* p. 265, § 447 *b;* p. 277, § 447½ *f;* p. 345, § 516 *d,* No. 6; p. 362, § 530; p. 456, § 698; p. 515, § 819 *b;* p. 540, § 851 *c;* p. 542, § 854 *bb.*
its advantages to medicine, p. 171–173, § 350, Nos. 41–46; p. 174–178, § 350½–350¾.
its confirmation or overthrow, p. 148, § 335; p. 542, § 854 *bb.*
problems for its solution, p. 16, § 14 *c;* p. 85, § 175 *c;* p. 94, § 188½ *d;* p. 155, § 349 *e;* p. 281–283, § 450 *d*–451 *f;* p. 330, § 500 *n;* p. 377, 379.
ORGANIC CHEMISTRY AND THE NUMERICAL METHOD,
important "Instruments" in medicine, p. 161, § 350, No. 14; p. 762, 763, § 1006 *a.*
their parallel, p. 762, 763, § 1006 *a.*
ORGANIC CHEMISTRY AND PHYSIOLOGY,
contrasted, p. 19, § 18 *e;* p. 157–173, § 350; p. 189, 190, § 350¾ *n;* p. 191, § 351; p. 246, § 440 *f;* p. 277, 278, § 447½ *f;* p. 514, 515, § 819.
one destructive, the other formative and conservative, p. 8, § 5; p. 13, § 5½ *b;* p. 18, § 18 *c;* p. 24, § 42; p. 33, § 60; p. 34–36, § 62; p. 37–40, § 64; p. 135, § 301.
ORGANIC COMPOUNDS,
their four principal elements, p. 23, § 37; p. 27, § 53 *b;* p. 33, § 61, 62; p. 44, § 72.
always consist of three or more elements intimately combined, p. 16, § 17; p. 227, § 411.

Organic Compounds—*continued.*
formed of combustible substances, proper, of supporters of combustion, and nitrogen gas, p. 33, § 61.
formed out of a homogeneous fluid of seventeen elements, p. 24, § 42.
formed originally by plants, p. 15, § 10, 13; p. 135–138, § 298–303½.
when decompounded, how restored, p. 15, § 13, 14.
mode in which their elements combine, p. 23, § 37–39; p. 24, § 42; p. 26, § 48; p. 27, § 51, 52, 53 *b;* p. 44, § 72.
contradistinguished from mineral compounds, p. 20–27, § 19–51; p. 221–227, § 409 *b*–411.
progressively advanced, p. 24, § 42.
hold different ranks, p. 24, § 42.
different in every part, p. 25, § 44; p. 27, § 53 *b;* p. 222–225, § 409.
variety of, p. 24, § 41; p. 44, § 72; p. 221–227, § 409 *b*–411.
not formed in the blood or sap, p. 24, § 42; p. 28, § 53 *b, c;* p. 44, § 72; p. 217, § 401 *b,* 402; p. 218, § 404; p. 219–227, § 407–411. See, also, PROTEIN.
confounded by chemistry, p. 29, § 54 *b.*
uniform in health, p. 21, § 22; p. 24, § 42; p. 25, § 44; p. 26, § 48; p. 27, § 53 *b;* p. 44, § 72; p. 223–227, § 409 *f*–411.
exactly variable in disease, p. 21, § 22; p. 25, § 44; p. 87, § 182 *a;* p. 105, § 220, 221; p. 435, § 680; p. 452, § 693; p. 473, § 733 *c;* p. 474, § 733 *f;* p. 478, 479, § 739–741; p. 517, 518, § 822; p. 536–538, § 847 *c–f.*
fundamental cause of their differences, p. 27, § 52, 53 *b.*
their chemical analysis uncertain, p. 16, § 15; p. 18, § 18 *d;* p. 26, § 48; p. 27–29, § 53, 54.
their complexity, p. 24, § 41, 42; p. 25, § 43; p. 26, § 49; p. 32, § 60; p. 44, § 72.
their putrefaction and fermentation, p. 28, § 54; p. 30–32, § 59; p. 34–36, § 62; p. 96, § 189 *c.*
their elements united by *vis vitæ,* p. 30–32, § 58, 59; p. 33, § 60; p. 36, § 62 *i;* p. 37–44, § 64–72.
when dead, *vis inertiæ* succeeds to *vis vitæ,* p. 30, 31, § 59.
their artificial transformations, unnatural, p. 28, 29, § 53 *b*–54 *b;* p. 228, § 417.
chemical influences upon, suppose chemical decompositions and recombinations, p. 28, § 53 *b;* p. 228, § 417 *a.*
their *nature* disturbed by any chemical influence, p. 28, § 53 *b;* p. 29, 30, § 56, 57; p. 228, § 417 *a.*

Organic Compounds—*continued.*
when dead, their condition affected by pre-existing vital influences, p. 28, § 54 *a.*
their chemical decomposition rapid, p. 29, 30, § 54 *a*, 56; p. 34–36, § 62.
their dissolution greatly owing to nitrogen gas, p. 34–36, § 62.
their dissolution promoted by the complexity of their elements, p. 36, § 62 *h*, and by water or its elements, p. 35, § 62 *g*.
ORGANIC FORCE, CHEMICAL THEORY OF,
oxydation of the blood and tissues, p. 157, 158, 159, § 350, Nos. 3, 4, 5, 7, 8, 9; p. 274, § 447½ *a*, No. 2.
the cause and the effect, p. 7, § 4½ *d;* p. 84–86, § 175 *c, d;* p. 90, § 188½ *d;* p. 154, 155, § 349 *c, e;* p. 254, § 441 *e;* p. 274, § 447½ *a.* See VITAL PRINCIPLE, and VITAL PROPERTIES.
ORGANIC FUNCTIONS,
their general consideration, p. 126–280, § 251–449.
common to plants and animals, p. 125, § 249.
their designations, *motion, absorption, assimilation, distribution, appropriation, excretion, calorification, generation*, p. 125, § 249.
the most essential carried on by the extreme vessels, p. 36–41, § 63–72. See, also, CAPILLARIES, CAPILLARY ACTION, and CIRCULATION, CAPILLARY.
ORGANIC HEAT,
vital and Chemical Theories of, p. 234–279, § 433–448.
its interpretation abandoned to chemistry, p. 234, § 433; but is only one among many corruptions in Physiology, p. 235, § 433.
Crawford's theory of, p. 235, § 434, 435 *a.*
Bichat's theory of, p. 236, § 437 *a;* p. 262, § 445 *g;* p. 266, § 447 *d;* p. 270, § 447 *d.*
Hunter's theory of, p. 237, § 437 *b.*
Philip's theory of, p. 237, § 437 *c;* p. 263, § 446 *b.*
Moore's theory of, p. 237, § 437 *d.*
Müller's theory of, p. 237, § 437 *e.*
Tiedemann's theory of, p. 237, § 437 *f.*
Carpenter's theory of, p. 237, § 437 *g.*
Edward's theory of, p. 237, § 438 *a;* p. 248, § 441 *b;* p. 255, § 441½ *a;* p. 271, 272, § 447 *g.*
Elliotson's theory of, p. 273, § 447 *h.*
Billing's theory of, p. 238, § 438 *b.*
Roget's theory of, p. 238, § 438 *c.*
Distinction between Liebig's and the last two, p. 238, § 438 *d.*
Liebig's theory of, as of all organic processes and results, combustion, or the union of oxygen with carbon and

Organic Heat—*continued.*
hydrogen, p. 239–248, § 440–441 *b*, p. 252, § 441 *c;* p. 254, 255, § 441 *e, f;* p. 260, § 445 *b;* p. 264, § 446 *c;* p. 274–278, § 447½.
conflict in the chemical statements of, p. 239, 240, § 440 *a, b;* p. 252, § 441 *c;* p. 246, § 440 *f;* p. 254, 255, § 441 *e, f;* p. 260, § 445 *b;* p. 264, § 446 *c;* p. 271, § 447 *f, g;* p. 273, § 447 *h;* p. 274–278, § 447½.
theory of, regarding the conversion of fluids into solids, p. 273, § 447 *h*, and *ut supra.*
contingent aid required by the theory of combustion, p. 239–244, § 440, Nos. 3, 7, 8, 9, 11, 11½, 12, 13, 14; p. 245, § 440 *e;* p. 247, § 440, No. 19; p. 248, § 441 *a–c;* p. 252, § 441 *c;* p. 254, § 441 *e;* p. 257, § 442; p. 264, § 446 *c;* p. 274–278, § 447½.
not regulated by the quantity or quality of food, p. 239, 240, § 440 *a;* p. 242–244, § 440 *c, cc;* p. 248–253, § 441 *b–d.*
chemical hypothesis of, founded mostly upon facts and assumptions relative to man, and man in health, p. 239, § 440 *a*, No. 3; p. 243, 244, § 440 *cc*, No. 12; p. 248, § 441 *b;* p. 275, § 477½ *b.*
in its relation to the law regulating the interchanges of caloric among inanimate objects, p. 244–246, § 440 *e.*
chemical parallels of, with inorganic processes, and artificial mechanisms, p. 177, 178, § 350¾; p. 238, § 438 *b, c.*
its supposed connection with exercise, p. 240, § 440 *a*, No. 8; p. 243, 244, § 440 *cc*, No. 12.
its supposed connection with alcohol and cold water, p. 240, § 440 *a, b.*
why reduced and exalted by cold, p. 245, 246, § 440 *e.*
its greater evolution from animal than vegetable food, and from alcohol than water, and in their connection with different climates, explained against organic chemistry, p. 240, § 440 *b;* p. 245, § 440 *c;* p. 250–252, § 441 *c;* p. 257, § 442 *b;* p. 335, 336, § 512, 513; p. 394–396, § 617–621.
chemical philosophy of, in relation to meat, fat, tallow, wine, and bile, and objections, p. 67, 68, § 151, 152; p. 240–243, § 440 *a–c;* p. 247, § 440 *i.*
supposed dependence of, upon clothing, p. 239, § 440 *a*, No. 3; p. 241, § 440 *bb*, No. 9; p. 242, § 440 *c;* p. 245, 246, § 440 *e;* p. 249, 250, § 441 *c;* p. 256, § 441½ *c;* p. 257–259, § 442.
its uniformity in all warm-blooded non-hybernating vertebrata, under all circumstances of heat, cold, food, clothing, &c., p. 242, § 440 *c;* p. 245, 246,

Organic Heat—*continued.*
§ 440 *e;* p. 249, 250, § 441 *c;* p. 258, 259, § 442 *d, e.*
more uniform in warm-blooded vertebrata than any other product, p. 245, § 440 *e;* p. 253, § 441 *d.*
variable in cold-blooded animals and insects, according to the external temperature, their vital constitution, and diseases, p. 252, § 441 *c;* p. 255, § 441½ *a;* p. 259, 260, § 443, 444.
generated by cold-blooded animals and insects, p. 246, § 440 *e.*
less uniform in cold-blooded animals than any other product; see *as above.*
generated by the egg, p. 30, § 57; p. 97, § 190 *b;* p. 256, § 441½ *d;* p. 260, § 445 *b.*
generated by plants, p. 256, § 441½ *a;* p. 260–262, § 445.
a product of secretion, p. 263, § 446; p. 273, § 447 *h.*
influenced by age and constitution, p. 68, 69, § 153–156; p. 248, § 441 *b;* p 255, § 441½ *a;* p. 257, 258, § 442 *a, b;* p. 259, 260, § 443–445 *b;* p. 262, § 445 *f;* p. 271–273, § 447 *g, h;* p. 275, § 447½ *b;* p. 384, § 585 *c, d,* 586; p. 391, § 603.
its vital nature shown by hereditary constitution, p. 257, 258, § 442 *b.*
parallel in its production, between the warm-blooded non-hybernating mammalia (young and old), warm-blooded hybernating mammalia, cold-blooded animals, eggs, and plants, and the coincident philosophy of, p. 245, 246, § 440 *e;* p. 248, § 441 *b;* p. 253, § 441 *d;* p. 255–263, § 441 *f* –446 *a;* p. 272, § 447 *h;* p. 63, § 137 *e;* p. 68, § 152.
amount generated by warm-blooded animals depends upon the nature of the species, and not at all upon any given amount of food, clothing, degree of external temperature, &c., p. 242–245, § 440 *c–e;* p. 249, 250, § 441 *c;* p. 257–259, § 442–443.
influenced by sympathy, p. 270, § 447 *d.*
influenced by the nervous power, p. 262–264, § 446.
greatly affected by disease, injuries, paralysis, &c., p. 259, § 443 *b;* p. 264–270, § 447 *a–d;* p. 272, § 447 *g.*
exalted in disorganized states of the lungs, p. 268, 269, § 447 *d.*
influenced by climate, through the law of vital habit, p. 256, § 441½ *a–c;* p. 258, § 442 *b, c;* p. 363, § 535–540; p. 394–396, § 615–621.
influenced by habits of exposure to cold, by clothing, &c., through the law of vital habit, p 257, 258, § 442 *a–d.*
its vital nature shown in plants by the adaptation of tropical to cold climates, by the rapidity with which the tropical may be made to endure a frosty atmosphere, by the evergreens of northern latitudes, &c., *ibid,* and Vital Habit.
its relation to vital habit explains the dissemination of animals from the region of the Ark, p. 258, § 442 *b, c;* p. 363, § 537–540; p. 364, § 544, 548; p. 369, § 562; p. 391, § 603; which is farther illustrated by transferring plants from southern to northern climates, *ut supra.*
its far more rapid reduction, or exaltation, in disease, by a small loss of blood, than by all other causes conjoined, a proof of its independence of combustion, p. 269, § 447 *d.* See, also, Loss of Blood, and *hybernating animals,* as below.
its remarkable vicissitudes in hybernating animals, and derivative proof of its vital production, p. 253, § 441 *d;* p. 255, 256, § 441½ *a, b;* p. 264, § 446 *d.*
supposed dependence of, upon the red globules of blood, and objections, p. 255, § 441 *f;* p. 260, 261, § 445 *b–e;* p. 274–278, § 447½.
generated according to the nature of the part, p. 61, 62, § 133 *b,* 134–136; p. 67, § 150, 151; p. 97, 98, § 190, 191; p. 260, § 445 *a, b;* p. 268, 270, § 447 *d.*
why it sometimes rises just antecedently to death, p. 269, § 447 *d.*
why it rises after death, p. 266, 267, § 447 *d.*
has one provision for the *lungs,* and another for "*the rest of the body,*" p 276, 277, § 447½ *f.*
Organic Kingdom. See the topics relative thereto.
Organic Life,
its laws sought in the ovum, p. 36–49, § 63–81.
changes in, as constituted by temperament, domestication of animals, cultivation of plants, and disease, have their type in the ovum, p. 44–49, § 72–80.
resists chemical agencies, p. 29–33, § 55–60; p. 34, § 62 *c.*
its organs, p. 54, § 105, 107, 111; p. 57, § 125.
its most essential organs, p. 40, § 65; p. 42, § 67; p. 54, § 109, 110; p. 55, § 115; p. 56, § 122; and are blended in all parts, p. 54, § 109 *b,* 110; p. 55, § 113–117. See, also, Capillaries, and Circulation, Capillary.
its great immediate office nutrition and vital decomposition, p. 53, § 104; p. 129, § 273.

Organic Life—*continued.*
its great final cause in respect to the species, the development of the generative organs, and the production of germs, p. 56, § 121.
its several functions, p. 54, § 105. See, also, Organic Functions.
begins in plants, p. 15, § 10, 14; p. 16, § 16, 17; p. 135, § 298–301, 303; p. 137, § 303½; p. 201, § 374, 375.
never generates an inorganic substance for organic purposes, nor carries backward, in the animal organization, an organic compound, p. 15, § 13, 14; p. 24, § 42; p. 30, § 59; p. 33, § 60; p. 135, § 301; p. 196, § 360; p. 201, § 374, 375.
its simplicity in plants in respect to organization, p. 54, § 107; p. 58, § 129 *f;* p. 135, § 202; p. 136, § 303.
in plants the whole being, p. 55, § 114; p. 88, § 184, 185.
complexity of its organs in animals, p. 54–56, § 111–120; p. 57, § 125; p. 135, § 302 *a;* p. 140–143, § 304–319.
its comprehensive system of connected Designs, p. 143–146, § 322–326. See, also, Design.
how distinguished from animal life, p. 53, § 98–104; p. 54, § 106, 108, 110, 111; p. 55, § 112–117. See, also, Life, Animal.
indispensable to animal life, p. 54, § 108, 110; p. 55, § 115.
subordinate to animal life, in its comprehensive Design, p. 15, § 10–14; p. 55, § 113, 114; p. 135, § 298, 300.
gives rise to the same diseases in the organs of animal as of organic life, p. 55, § 117.
the whole life of the fœtus, p. 53, § 103. See, also, Nerves.
has no repose but in the germ, p. 30, § 57; p. 53, § 102; p. 97, § 190 *b.*
harmonious in its laws and phenomena, p. 1, § 1; p. 3, § 2, *b, d;* p. 14, § 6; p. 41, § 65; p. 44, § 72; p. 47–49, § 75–80; p. 55, § 117; p. 58, 59, § 129; p. 61, § 133 *c;* p. 62, 63, § 135–137; p. 65, § 143 *c;* p. 67–69, § 149–156; p. 81, § 169 *f;* p. 85, § 175 *c;* p. 87, § 177–182; p. 88, 89, § 185–188; p. 90, § 188½ *a–d;* p. 93–95, § 188½ *d;* p. 96–99, § 189 *c*–192; p. 101, 102, § 201–203; p. 103, § 205 *a*, 207, 208; p. 104, § 215; p. 105, § 220 *a;* p. 106–111, § 223–233¾; p. 120–122, § 237–240; p. 124, 125, § 243–246; p. 128, § 266; p. 129, 130, § 273, 277–279; p. 131–133, § 285–291; p. 135, § 300, 301; p. 137, § 303 *e*, 303½ *a;* p. 140–147, § 304–330; p. 148, 149, § 336; p. 191, 192, § 351–353; p. 209, § 384,

Organic Life—*continued.*
385; p. 212, § 392; p. 216, § 399; p. 217, § 401 *b;* p. 222–234, § 409 *c*–433; p. 271, § 447 *f;* p. 272, 273, § 447 *h;* p. 279, § 449; p. 282, § 451; p. 283, § 452 *a, c;* p. 284–287, § 454–458; p. 290, § 464, 465; p. 323–332, § 500; p. 405–412, § 638; *and so on.*
contrasted with the condition of dead matter, p. 23–73, § 34–163; p. 434, 435, § 680. See, also, Properties of Life, Functions, Age, Sex, and Death.
its results always uniform under any given combination of circumstances, p. 120, 121, § 237; p. 227, § 411; p. 405–412, § 638; p. 442, § 686 *d;* p. 489, § 756 *b;* p. 619, § 892½ *r.* See, also, *Harmonious in its Laws*, as above; and Design, Therapeutics, &c.
contradistinguished from chemical and mechanical philosophy. See Organic Chemistry.
involves in animals the two properties which are specifically designed for animal life. See Vital Principle, Vital Properties, Nervous Power, and Sensibility. See, also, Life.

Organic Processes,
type of, in the germ, p. 36–49, § 63–81.
proof of their universal vital nature derived from the function of generation, p. 280, § 449 *d.*

Organic Properties,
common to plants and animals, p. 88, § 183, 184 *a.*
modified in each department, p. 88, § 185. See Vital Properties, and Vital Principle.

Organism,
the universal body, p. 52, § 89.
radiated, p. 53, § 93.
symmetrical as a whole, p. 53, § 95.
composed of two systems; one relative to the individual, the other to the species, p. 53, § 96, 97.
the animal founded on the organic, p. 53, § 98–103; p. 54, § 108, 110, 111; p. 55, § 114–117; p. 143–146, § 322–326.

Organization,
beginning of in plants, p. 15, § 10, 14 *a.*
rudiments of, p. 41, § 65; p. 46, § 74.
its simplicity in plants, p. 54, § 107; p. 135, § 302.
and vital properties, mutually dependent, p. 16, § 14 *c;* p. 81, § 170.
its most essential part, p. 54, § 109 *b.*

Organized Structure. See Structure.

Organs, Development of. See Development.

ORGANS OF ANIMAL LIFE,
their designation, &c., p. 54, § 106; p. 58, § 127.
their subserviency to organic life, p. 54, 55, § 111–117; p. 106, § 223; p. 108, § 228; p. 111, § 233¾; p. 144–146, § 323–326; p. 282–289, § 451 c–461½; p. 325, § 500 e; p. 332, § 501 c; p. 338, 339, § 514 f, g.
not necessary to organic life, p. 54, § 108. See, also, ORGANIC LIFE, and NERVES.

ORGANS OF ORGANIC LIFE,
arrangement of, according to their functions, p. 57, § 125.
compound, p. 52, 53, § 89, 92.
their sympathetic relations, p. 58, § 129 *c–f*.
their relations liable to derangements, p. 59, § 129 *g–i*; p. 361, 362, § 529. See, also, LAWS OF SYMPATHY, and NERVOUS POWER.
their mechanical relations, p. 59, § 129 *k*.
indispensable to animal life, p. 54, § 108.
indispensable to each other, p. 54, § 109.
general nature of the relations between the organs of organic and of animal life, p. 55, § 111–117.

OVUM,
its state of life, p. 30, § 57; p. 36–42, § 63–66; p. 97, § 190 *b*; p. 104, § 212.
its principle of development, p. 37–40, § 64–65.
vital Theory of its development, p. 41, § 65.
chemical Theory of its development, p. 190, 191, § 350¾ *n*.
special circumstances attending its condition and development, p. 56, § 122; p. 97, § 190 *b*; p. 104, § 212.
its vital modifications, p. 44, § 72; p. 56, § 122, 123; p. 97, § 190 *b*; p. 104, § 212.
how impressed in fecundation, p. 44, 45, § 72–73; p. 97, § 190 *b*; p. 104, § 212.
its development a type of all organic processes, p. 45, § 73 *b*; p. 68, § 153–156 *a*.
its development supplies a type of all diseases, p, 45, § 72; p. 47–49, § 75–80.
transmits disease, p. 47, 48, § 76–78.
potentially the future being, p. 40, § 65.
illustrates the general character of the properties of life, p. 41, § 72; p. 47–49, § 75–80; p. 256, § 441½ *d*.
illustrates the philosophy of hybrid animals and hybrid plants, p. 44, 45, § 72.
its supposed nucleus of a cell, p. 42, § 67; p. 50, § 83 *b*; p. 60, § 131.

Ovum—*continued.*
its peculiarities in different tribes, p. 56, § 122; p. 97, § 190 *b*.
oviparous and viviparous, distinctions between, p. 45, § 73 *a*; p. 97, § 190 *b*.
organic life alone in operation during its development, p. 53, § 103.
development of its nervous system, organs of sense, and voluntary muscles, like that of the liver, stomach, &c., designed for independent life, and the work of development devolves, therefore, upon the extreme vessels, p. 42, § 67; p. 54, § 109; p. 284, § 455 *a*, *b*; p. 286, § 456; p. 289, § 461½ *a*; p. 342–353, § 516–524.
its power of resisting external influences, p. 30, § 57; p. 56, § 123; p. 256, § 441½ *d*.
evinces great Design, p. 56, § 123; p. 97, § 190 *b*. See NERVES, *their early development*, &c.

OXYDATION OF THE BLOOD AND BODY. See COMBUSTION, and ORGANIC HEAT.

OXYGEN,
its relative connection with animals and plants, p. 137–139, § 303¼–303¾.
its connection with respiration, p. 229, § 419; p. 266, § 447 *d*; p. 268, § 447 *d*; p. 270, § 447 *e*; p. 274–278, § 447½.
a test of the assumed dependence upon, of *motion* and animal heat, p. 255, § 441 *f*.
its connection, in organic chemistry, with the various processes and results of life. See COMBUSTION, and PHYSIOLOGY, in relation to the *red globules of blood*.
Christison's observations upon in disease, p. 270, § 447 *e*.
its relative connection with the generation of heat and other products of organic beings, p. 273, § 447 *h*.

P.

PAIN,
rarely a cause of disease, p. 588, § 891 *m*.
does not affect organic actions in health, p. 79, § 167, *note*; p. 588, § 891 *m*.
should not be prevented, nor assuaged, by means which may endanger life, p. 584, § 891 *c*, *d*; p. 587, § 891 *k*; p. 593, § 891½ *k*. See, also, NARCOTICS.

PARALYSIS,
prevents the operation of the will by embarrassing its action upon the nervous power. See WILL, NERVOUS POWER, NARCOTICS, MOTION, and ANALOGIES.

PAST AND PRESENT, p. 203–207, § 376¾ *a*.

Pathology,
its general survey, p. 413–540, § 639–851; comprehending *Remote Causes,* p. 414–427, § 644–666; *Proximate or Pathological Cause,* p. 427–434, § 667–676; *Symptoms,* p. 434–455, § 677–694½; *Morbid Anatomy,* p. 456–463, § 695–709; *Inflammation,* p. 464–489, § 710–756; *Fever,* p. 489–499, § 757–785; *Venous Congestion,* p. 500–513, § 786–818; *Humoralism,* p. 514–540, § 819–851.
objects and nature of, p. 3, § 2; p. 413, 414, § 639–642.
to the physician the great final object of physiology, p. 3, § 2 *b;* p. 413, § 639 *a.*
reflects light upon physiology, p. 73, § 163; p. 107–111, § 225–233¾.
the Chemical System of, p. 171–173, § 350, Nos. 41, 42, 43, 44, 45, 46; p. 174–176, § 350½ *a–g;* p. 251, 252, § 441 *c;* p. 515, § 819 *b;* p. 517, § 821 *c.*
Pancreas,
developed from intestinal canal, p. 41, § 65. See, also, Assimilation.
Passions. See Mental Emotions.
chemical theory of, p. 155, § 349 *e.* See, also, Combustion.
Perception,
necessary to true sensation, p. 89, § 186; p. 100, § 196; p. 124, § 242; p. 282, § 451 *c.*
not concerned in the function of *sympathy,* p. 54, 55, § 111–117; p. 101, 102, § 201–203; p. 125, § 245, 246; p. 282, § 451; p. 283, § 452.
Phenomena,
the foundation of philosophy. See Effects.
Philanthropy,
indispensable in medical philosophy, as in the practice of medicine, p. 122, § 240, &c.
Philip, Wilson,
his *Experiments to determine the Laws of the Vital Functions,* p. 110, § 233.
neglected, p. 112, § 234 *b.*
statement of his, and analogous experiments by others, and the *author's* inductions from them, p. 290–321, § 462–494.
Philosophy,
portents of coming changes in, p. 7, § 4½ *b;* p. 8, 9, § 5; p. 14, § 6; p. 174, § 350½; p. 203–207, § 376¾; p. 460–463, § 709, *note.* See, also, Physiology and Organic Chemistry, *contrasted.*
neglected, p. 112, § 234 *b;* p. 154, § 349 *d;* p. 202, § 376½; p. 219, § 408; p. 234, 235, § 433; p. 434, § 676 *b;* p. 457, § 699 *c;* p. 482, § 744; p. 484, § 748; p. 515, § 819 *b;* p. 715–721, § 960 *a.*
its limits, p. 185, § 850¾ *k;* p. 206, § 376¾ *a;* p. 317, § 493 *a;* p. 719, 720, § 960 *a.* See, also, Science.

Philosophy—*continued.*
true and *false,* illustrated in the characters of *Pythagoras* and *Anaxagoras,* p. 482, § 744.
false, illustrated by prevailing fabrics in medicine, p. 174–178, § 350½–350¾; p. 484, 485, § 748, 749; p. 515–519, § 819 *b*–825.
Phlebitis. See Venous Congestion, and Venous Tissue.
Phthisis Pulmonalis,
an inflammatory disease, in all its phases, and demanding loss of blood, and a strictly antiphlogistic treatment in its early stages, and abstinence from meat in the more advanced, p. 457, § 699 *c;* p. 458, § 700 *b;* p. 459, § 705; p. 471, § 732 *d;* p. 546–551, § 862–864; p. 573, § 890 *e;* p. 338–341, § 892⅘ *g–i;* p. 765, 766, § 1007–1008. See, also, Medical and Physiological Commentaries, vol. ii., p. 608–634; p. 743–746.
Physiologists,
their duty to their own science, p. 2, § 1 *b;* p. 8, § 5; p. 122, § 240; p. 202, § 376½; p. 207, § 376¾ *b;* p. 277, § 447½ *f;* p. 429, § 674 *a;* p. 762, § 1006 *a.*
their proper vocation, p. 2–4, § 2; p. 10–14, § 5½–6; p. 202, § 376½; p. 207, § 376¾ *b;* p. 239, § 438 *d;* p. 279, § 448; p. 330, § 500 *n;* p. 429, § 674 *a.*
the proper ground for their inductions, p. 10, 11, § 5¼; p. 115, § 234 *e;* p. 429, § 674 *a;* p. 434, 435, § 679, 680. See, also, Facts.
Physiological States,
inferred from morbid states, p. 61, § 134; p. 64, § 140; p. 73, § 163; p 107–111, § 225–233¾; p. 265, § 447 *a–c;* p. 272, § 447 *g;* p. 501–512, § 791–817.
inferred from the natural products, p. 62, § 135.
inferred from natural stimuli, p. 62, § 136; p. 97, § 190; p. 98, § 191 *a;* p. 100, § 199, 201.
inferred from the action of morbific agents, p. 63, § 137; p. 64, § 142; p. 66, § 143; p. 67, § 149, 150; p. 68–73, § 153–162; p. 98, § 191.
govern the morbid states, p. 67, § 149, 150; p. 107–111, § 225–233¾.
do not teach the morbid states, only as they are illustrated by the morbid, p. 3, § 2 *c,* and *as above.* See, also, Remedies, their Capabilities and Effects.
not taught by Anatomy, p. 3, § 2 *c;* p. 50, § 83 *c;* p. 59, § 131. See, also, Morbid Anatomy.

PHYSIOLOGY,
its general survey, p. 15–412, § 7–638.
objects of, p. 3, § 2.
regards Nature according to her ordinations, p. 3, § 2 *b;* p. 11, § 5 ¼ *e;* p. 12, § 5¼ *f*, 5½ *a;* p. 330, § 500 *n*.
schools of, p. 6, § 4½.
considered under seven divisions, p. 22, § 31.
not learned from anatomy, p. 3, § 2 *c;* p. 50, § 83 *c;* p. 59, § 131.
its relations to pathology and therapeutics, p. 1, § 1; p. 2, 3, § 2; p. 55, § 115–117; p. 58, § 129; p. 61–70, § 133–160; p. 98, § 191; p. 102, § 202; p. 107–122, § 225–240; p. 131, 132, § 284–288; p. 331, § 500 *c;* p. 398, § 626; p. 405–413, § 638, 639; p. 541, § 852.
vitiated by experiments, p. 11–13, § 5¼ *e*, *f*, 5½ *a;* p. 14, § 6; p. 17, § 18 *e;* p. 26, § 48; p. 28, § 53 *c;* p. 132, 133, § 289–291; p. 148, § 334, 335; p. 173, § 350¼; p. 179–182, § 350¾ *c–g;* p. 196–198, § 360–364; p. 200, § 366; p. 202, § 376½; p. 485, § 749; p. 518, § 823.
how far surrendered to Chemistry, p. 8, 9, § 5; p. 13, § 5½ *a;* p. 148, § 335; p. 155, § 349 *d;* p. 176, § 350½ *q;* p. 202, § 376½; p. 235, § 433.
the qualifications of chemists for its investigation, p. 7, § 4½ *d;* p. 8, 9, § 5; p. 11, § 5¼ *c*, *d;* p. 157–173, § 350, Nos. 3–46; p. 174–182, § 350½–350¾ *g;* p. 202, 203, § 376½; p. 239, § 438 *d*.
its essential philosophy, as well as of disease, supposed to reside in the red globules of blood, p. 157–160, § 350, Nos. 1–10; p. 161–163, § 350, Nos. 15–19; p. 174–178, § 350½–350¾; p. 208, § 383 *a;* p. 251, 252, § 441 *c;* p. 254, 255, § 441 *e*, *f;* p. 260, § 445 *b;* p. 274–278, § 447½.
demonstrative proof of the error of the grand doctrine in organic chemistry, that *motion* and organic results depend upon oxygen gas, p. 255, § 441 *f;* p. 318–321, § 494. See, also, COMBUSTION.
PHYSIOLOGY AND ORGANIC CHEMISTRY CONTRASTED, p. 19, § 18 *e;* p. 157–173, § 350; p. 189, 190, § 350¾ *n;* p. 191, § 351; p. 246, § 440 *f;* p. 277, 278, § 447½ *f;* p. 514, § 819 *a*, Nos. 1–7. See, also, ORGANIC CHEMISTRY, *contradistinguished from*, *&c*.
PHYSIOLOGY, SUMMARY CONCLUSION OF, OR ITS UNITY OF DESIGN, p. 405–412, § 638.
PLANTS,
indispensable to animals, p. 15, § 13, 14; p. 17–20, § 18; p. 135–139, § 298½–303.
Plants—*continued.*
subsist on mineral substances, p. 15, § 11, 14; p. 16, § 16; p. 20, § 18 *e;* p. 135–139, § 298–303½.
their food originally from the atmosphere, p. 16, § 16; p. 135–138, § 303–303¼.
have greater organizing power than animals, p. 15, § 11; p. 24, § 42; p. 105, § 217; p. 135, § 298, 300.
their simplicity of life, p. 55, § 114; p. 58, § 129 *f;* p. 88, § 185; p. 135, § 302; p. 140, § 304.
their organic properties, p. 88, § 183, 184; p. 93, § 188½ *d;* p. 105, § 217.
their life essentially the same as that of animals, p. 14, § 6; p. 15, § 8–10, 12–14; p. 21, 22, § 19–30; p. 23, 24, § 34–42; p. 26, § 47–49; p. 27, § 52, 53; p. 29, § 54 *a;* p. 30–36, § 56–62; p. 44, § 72; p. 45, § 73 *b;* p. 48, § 77; p. 49, § 80; p. 51, 52, § 84, 85; p. 54, § 107–109; p. 55, § 112–115; p. 56, § 121–123; p. 58, § 129 *f;* p. 68, 69, § 153–157; p. 82, § 170 *a*, 171; p. 83, § 172–174; p. 86, § 176; p. 88, § 184 *a*, 185; p. 89, § 188 *a;* p. 90, § 188½ *b*, *c;* p. 93–95, § 188½ *d;* p. 98, § 191 *a;* p. 103, § 207; p. 104, § 214; p. 105, § 217; p. 127, § 261–264; p. 129, 130, § 277, 278; p. 132–134, § 289–295; p. 140, § 304; p. 163–167, § 350, Nos. 64–77, and Nos. 26½, 27, 51; p. 207, 208, § 381; p. 224, 225, § 409 *g–i;* p. 226, 227, § 410, 411; p. 260–262, § 445 *a–f;* p. 273, § 447 *h;* p. 280, § 449 *d;* p. 283, § 452 *a;* p. 284, § 454, 455; p. 286, § 456 *a;* p. 289, § 461½ *a;* p. 345, 346, § 516 *d*, No. 7; p. 391, 392, § 603–606; p. 395, § 618 *b;* p. 435, § 680; p. 442, § 686 *d;* p. 474, 475, § 733 *f–i;* p. 619, § 892 *r;* p. 746, § 990½ *b*.
their creation before animals, *Author's* proof of, p. 135, 136, § 303 *a;* p. 137, 138, § 303¼ *b*, *c*.
essentially independent of animals, p. 15, § 11–14; p. 16, § 16, 17; p. 135, 136, § 303 *a;* p. 137, 138, § 303¼ *b*, *c*.
the beginning of organic compounds, p. 15, § 10, 13, 14; p. 135–139, § 298–303¾.
their manifestations of vital motion, p. 103, § 207; p. 134, § 293, 294; p. 163–167, § 350, Nos. 63–77.
illustrate *continuous sympathy*, p. 58, § 129 *f;* p. 322, § 498 *c;* p. 351, § 524 *a*, No. 2.
the action of light upon, p. 46, § 74 *a;* p. 90–95, § 188½ *d;* p. 136, 137, § 303 *d*, *e;* p. 163–165, § 350, Nos 64–70.
their diseases, p. 93, § 188½ *d;* p 98,

Plants—*continued.*
§ 191 *a;* p. 322, § 498 *c;* p. 474, 475, § 733 *f–i.*
analogy traced between the process of regeneration in inferior animals, of the stag's horn, &c., and of reparation, ingrafting, &c., of plants, and the union of wounds by the adhesive process, and the dependence of the latter upon inflammation through the coincidence in the simultaneous effusion of lymph around the wall of an abscess, the formation of pus, the institution of the ulcerative process in the direction of the surface, and the ultimate cicatrization, and thence a close analogy between the vital constitution of plants and animals, and their morbid states, through an example parallel to an abscess, which is presented by the stem of trees, when circumscribed disease is set up beneath the surface, p. 88, § 185; p. 470, § 729 *a;* p. 471–476, § 732–733; p. 479, § 741 *b.*

PLANTS AND ANIMALS,
their fundamental distinction, p. 15, § 11–14 *b;* p. 17–20, § 18.
their composition, p. 15, § 12; p. 17–20, § 18; p. 23–28, § 34–53. See, also, PLANTS, and ORGANIC LIFE.

PNEUMOGASTRIC NERVE,
appertains to organic life. See NERVOUS POWER.

POLLEN,
analogous to semen. See SEMEN, and OVUM.

POULTICES, WARM,
their uses, and mode of operating, p. 681–683.

PORTAL CIRCULATION. See CIRCULATION, PORTAL.

POTASH, TARTRATE OF. See CATHARTICS, and THERAPEUTICS.

POTASH, SUPER-TARTRATE OF. See CATHARTICS, and REMEDIAL ACTION.

POTASH AND SODA, TARTRATE OF. See CATHARTICS, and THERAPEUTICS.

PRACTICE OF MEDICINE,
how taught in Hospitals. See HOSPITAL REPORTS AND PRECEPTS.

PREDISPOSITION TO DISEASE,
author's theory of, p. 47–49, § 75–81; p. 87, § 181; p. 368, § 559; p. 420–427, § 654–666; p. 429, 430, § 674 *d;* p. 669, 670, § 902 *i.*

PRINCIPLES,
importance of, p. 4, § 3, 4; p. 331, § 500 *o;* p. 489, § 756 *b.*
consistency, a test of, p. 1, § 1; p. 3, § 2 *c;* p. 331, § 500 *o;* p. 489, § 756 *b.* See, also, VITALISM AND SOLIDISM, and PHYSIOLOGY AND ORGANIC CHEMISTRY, *Contrasted.*

Principles—*continued.*
in *medicine,* from their diversity and discrepancy, form no test of the rights of membership of the medical profession, p. 77, *note;* p. 515, § 819 *b;* p. 529, § 835; p. 540, § 851; p. 558, § 878.
erratum, p. 77, third line from bottom, for *Moore* read *More.*

PROBLEMS,
one for *Organic Chemistry,* p. 281–283, § 450 *d*–451 *f;* p. 330, § 500 *n.*
another for *Mental Materialism,* p. 84, 85, § 175 *c;* p. 155, § 349 *e;* p. 281, § 450 *e;* p. 329, § 500 *n.*
another for *Atheism,* p. 16, § 14 *c.*

PROFESSION, MEDICAL, IN EUROPE AND THE UNITED STATES,
their relative merits. See MEDICAL EDUCATION.

PROPERTIES OF LIFE. See VITAL PROPERTIES.

PROTEIN,
an important "instrument" in Organic Chemistry, p. 17–20, § 18; p. 28, § 53 *c;* p. 219–222, § 409 *a, b;* p. 763, § 1106 *a.* See, also, MÜLDER'S REPLY TO LIEBIG, CONCERNING TRUTH AND PROTEIN. *London,* 1846.

PROXIMATE OR PATHOLOGICAL CAUSE OF DISEASE,
general consideration of, p. 427–434, § 667–676.
constitutes the disease itself, p. 427, § 668.
undergoes a constant succession of spontaneous or artificial changes during the progress of disease, p. 428, § 672.
the various changes result from the natural instability of the properties of life, *ibid.*
is the special object of all remedial agents, p. 428, § 673, &c. See, also, VITAL PROPERTIES, REMOTE CAUSES, and THERAPEUTICS.

PROXIMATE PRINCIPLES OF ORGANIC COMPOUNDS,
their reputed nature, p. 29, § 54 *b.*
are chemical transformations, p. 18, 19, § 18; p. 28, 29, § 53 *b*–54 *a.*
their true nature, p. 24, 25, § 42–44; p. 27, § 53; p. 40–42, § 65–66.

PULSE,
in its relation to disease, p. 443–448.

PUS,
depends upon inflammation. See INFLAMMATION, and DESIGN.

PUTREFACTION,
its causes and peculiarities, p. 28–31, § 54–59; p. 34–36, § 62. See, also, NITROGEN.
its principal cause evinces that it is not concerned in digestion nor in

Putrefaction—*continued.*
any process of organic life, *ibid.* See, also, DIGESTION.
more philosophically the cause of the explosion of gunpowder than of digestion or of the waste of living bodies, p. 35, § 62 *e*. See, also, DIGESTION, *Chemical Theory of*, and *Physiology of*, and DECOMPOSITION, VITAL.
incompatible with life, p. 16, § 17; p. 105, § 221; p. 533, 534, § 843. STAHL and JUNKER define "life as a state opposite to putridity."
rapid in dead animal compounds, p. 34, § 62 *c*; p. 96, § 189 *c*.
takes place under organic conditions, p. 28, § 54 *a*.
promoted mostly by nitrogen gas, p. 34–36, § 62.
important in the philosophy of Organic Chemistry and Humoralism, p. 167–170, § 350, Nos. 29–39; p. 172, § 350, Nos. 44, 45; p. 179, § 350¾ *c*; p. 181, § 350¾ *e*; p. 199, 200, § 365; p. 514, § 819 *a*, Nos. 1, 2, 3; p. 517, § 821 *c*; p. 529, § 835.
PYLORUS,
admits the passage of solid food, &c., through morbid changes of irritability, p. 99, § 192.

Q.

QUINIA,
its therapeutical uses, with various relative considerations, p. 593–607.

R.

RACES OF MANKIND,
evince the influences of climate, &c., without any remarkable physiological, but greater moral, distinctions, p. 391–393.
REASON,
its great characteristics, judgment and reflection, p. 123, § 241 *b*; p. 124, § 241 *c*.
the peculiar attribute of the soul, p. 123, § 241 *a*; p. 124, § 241 *c*.
contrasted with instinct, p. 123, 124, § 241 *b*, *c*.
its alliance to instinct, p. 123, 124, § 241 *c*.
as associated with instinct, a connecting moral medium between man and animals, p. 123, § 241 *c*.
the connecting link between man and his Maker, p. 124, § 241 *c*. See, also, TRUTH.
author's proof from, in connection with *instinct*, of the identity of mankind

Reason—*continued.*
in respect to species, p. 123, § 241 *c*, *note*. See, also, INSTINCT.
REFLEX ACTION,
its general philosophy known in former times; its mechanism and physiological laws lately determined, p. 290, § 462–465; p. 320, § 494 *dd*; p. 362, § 530. See, also, NERVOUS POWER, SENSIBILITY, SYMPATHETIC, and SYMPATHY.
RELATIONS, SYMPATHETIC,
of a general nature, p. 58, § 129; p. 63, § 137; p. 64–66, § 140–143. See, also, SYMPATHY, GANGLIONIC SYSTEM, and NERVOUS POWER.
mechanical, p. 59, § 129 *k*.
REMEDIAL ACTION, OR MODUS OPERANDI OF REMEDIES,
considered critically, p. 661–689. See, also, REMEDIES, *considered generally*, &c.
REMEDIES,
the cause of their differences, p. 27, § 52; p. 68, § 155. See, also, ANALOGIES.
their specific relations to organs, p. 63, § 137; p. 66, § 143. See, also, ADAPTATION, LAW OF.
their action accords with the existing condition of the vital states, p. 3, § 2 *b*; p. 59, § 129 *g–i*; p. 66–69, § 144–156; p. 73, § 163; p. 98, § 191 *b*; p. 122, § 240; p. 437–442, § 685–686. See, also, PATHOLOGY, and THERAPEUTICS.
analogous in action to morbific causes, p. 542, § 854; p. 662–665, § 895–901. See, also, REMEDIAL ACTION, and ANALOGIES.
their capabilities, effects, and doses, to be known only by their trial under various conditions of human maladies, and to be obtained only by a careful reference to their virtues and to the existing pathological conditions, p. 3, § 2 *c*; p. 63, § 137 *d*; p. 65, § 143 *c*; p. 67, § 150, 151; p. 122, § 240; p. 148, § 334; p. 417, § 650; p. 428, § 671–674 *a*; p. 430–433, § 675, 676 *a*; p. 434, § 680; p. 437–442, § 685, 686; p. 459, § 705; p. 464, § 712, 713; p. 486, § 750 *b*; p. 488, § 756 *b*; p. 528, § 831; p. 541, 542, § 854; p. 543, § 857; p. 545, § 859; p. 547, § 863 *d*; p. 565, § 889 *f*, *g*; p. 567–569, § 899 *l–mm*; p. 572–574, § 890 *d*, *e*; p. 575, 576, § 890 *h–l*; p. 577, 578, § 890 *o–q*; p. 580, 581, § 890½ *e–g*; p. 584, § 891 *d*; p. 586–589, § 891 *h–p*; p. 590–593, § 891½; p. 597–600, § 892 *c*, *d*; p. 608–610, § 892¼ *c*, *d*; p. 613, § 892½ *b*; p. 615, § 892½ *e*, *f*; p. 619, § 892½ *r*; p. 623, § 892¾ *c*; p. 625, § 892¾ *f*; p. 628, 629, §

Remedies—*continued.*
892¾ *q–s;* p. 630, § 892¾; p. 633–635, § 892⅘ *a–c;* p. 637–639, § 892⅘ *e–g;* p. 645, § 893 *c;* p. 649, 650, § 893 *h, i;* p. 652, 653, § 893 *m, n;* p. 657, 658, § 893 *p;* p. 662, 663, § 895–897; p. 664, § 900; p. 679–683, § 905; p. 684–688, § 905½ *b, c;* p. 692, 693, § 915–921; p. 698–700, § 929–935; p. 702, 703, § 939–942; p. 707, § 948, 949; p. 711–715, § 953–960; p. 724, § 961 *a;* p. 726, § 961 *c, d;* p. 732–734, § 971–975, *and so on.*
the philosophy of their action considered generally, and under various aspects, p. 3, § 2 *b;* p. 27, § 52; p. 44, § 72; p. 45, § 73; p. 55, § 117; p. 59, § 129 *h;* p. 61, § 133 *c;* p. 63, § 137; p. 65, § 143; p. 67, § 149–152; p. 73, § 163; p. 87, § 177–182; p. 89, § 188 *a;* p. 98, § 191 *a, b;* p. 99, § 192; p. 101–104, § 201–204; p. 100–111, § 223–233¾; p. 321–335, § 495–511; p. 405–412, § 638; p. 540, § 851; p. 662–665, § 895–901. See, also, Remedial Action, *considered critically.*
do not operate by absorption, p. 301–314, § 481–488½; p. 318–321, § 494. See, also, Humoralism, Remedial Action, Analogies, and Adaptation, Law of.
shown not to act upon any chemical or physical principle by the variety of agents which will remove a common form of disease, as the intermittent fever, or as iodine, mercury, quinia, &c., will alike induce absorption of lymph in indurated enlargements of the liver, &c., p. 133, § 291; p. 603, 604, § 892 *k, kk;* p. 615, 616, § 892½ *f;* p. 677–679, § 904 *d.* See, also, Absorption.
are constantly influenced by the order of their application, *ut supra.* See, also, Therapeutics, and Adaptation, Law of.
action of, often depends upon the effects of antecedent and subsequent remedies, *ibid,* &c.
can not be isolated from a consecutive series, and each one studied in its effects by itself. See general Therapeutics, Bloodletting, and Remedial Action.
Respiration,
physiology of, and its comprehensive exemplification of remote sympathy, p. 325–328, § 500 *e–m.*
in organic chemistry, the cause of all motions, processes, and results, the cause of itself, and the cause of death, p. 173, § 350, No. 46. See, also, Combustion.
Respiration—*continued.*
the death of organic chemistry, p. 243, § 440 *cc,* No. 12.
Revelation,
its fundamental statements coincide with the constitution and phenomena of nature, and their admission is indispensable to the progress of truth, and of science, p. 16, § 14 *c;* p. 23, § 34–36; p. 34, § 62 *c;* p. 46, § 74; p. 49, § 81; p. 86, § 175 *d;* p. 135–138, § 303–303¼; p. 174–192, § 350½–353; p. 317, § 493 *a;* p. 401, § 632 *b.* See, also, Design.
Revulsion,
objections to the doctrine of, p. 653–656, § 893 *n.*
Rochelle Salts. See Cathartics, Therapeutics, &c.
Rheubarb. See Cathartics, Astringents, Tonics, Alteratives, Therapeutics, and Remedial Action.
object of its arrangement among the Group of *alteratives;* see Oil, Castor.

S.

Saline Cathartics. See the several Denominations.
Sap,
composed of the same seventeen elements as blood, p. 23, § 34–37; p. 24, § 41, 42.
its motion shown to be a vital process by direct observation, and by the variety of unique eliminations from the sap, p. 24, § 41, 42; p. 134, § 293; p. 224–227, § 409 *g*–411. See, also, Assimilation, Absorption, Capillaries, and Plants.
Science,
must keep itself within the fundamental restraints of Revelation; see Revelation.
Sarsaparilla. See Alteratives, Iodine, and Remedial Action.
Scammony. See Cathartics, and Therapeutics.
Schools of Medicine,
three: Physiological or Vital, Chemical, and Chemico-physiological, p 6, 7, § 4½ *a–e.*
the Physiological contradistinguish organic and inorganic Nature, p. 6, § 4½ *a;* the Chemical confound organic and inorganic Nature, p. 6, § 4½ *b;* the Chemico-physiological compromise philosophy, p. 7, § 4½ *c;* p. 197, § 361.
Secretion,
the function upon which nutrition and growth immediately depend; better designated as Appropriation, p. 217–227, § 400–411.

Secretion—*continued.*
chemical philosophy of, p. 168–170, § 350, Nos. 31, 32, 37, 38, 39; p. 180–182, § 350¾ *e, f.* See, also, COMBUSTION.

SECRETIONS AND EXCRETIONS,
terms applied to the products of the functions, and used, at present, in their morbid acceptation, and as supplying symptoms, p. 450–455, § 690–694½.

SEDATIVES,
their uses and mode of action, p. 583–593, § 891–891½; p. 681–683, § 905 *b.* See, also, NARCOTICS, HYDROCYANIC ACID, and ANALOGIES.

SEED,
its state of life, p. 30, § 57; p. 97, § 190 *b.*
evinces great Design, p. 56, § 123; p. 97, § 190 *b.* See, also, OVUM.

SEMEN,
a vital stimulus, p. 44–46, § 72–73; p. 47–49, § 75–80; p. 97, § 190 *b.*
acts upon the ovum, p. 44, § 72; p. 97, § 190 *b.*
transmits disease, p. 47–49, § 75–80.
its analogies with other vital agents, p. 45, § 73, 74; p. 97, § 190 *b.*
imparts constitutional peculiarities, p. 44, § 72.
vicarious, p. 50, § 83 *b.* See, also, OVUM.

SENEKA,
its merits in croup, p. 638, § 892⅔ *f.*

SENNA,
objections to its common use; see CATHARTICS, and THERAPEUTICS.

SENSATION,
its philosophy, p. 89, § 186, 188 *b*; p. 100–103, § 194–204; p. 280–283, § 450–451.
of three kinds, *common, specific,* and *sympathetic,* p. 280–283, § 450–451.
common, the cause of pain, and universal, p. 100, § 198; p. 281, § 450 *d.*
specific, the function of the senses, and the fountain of knowledge, p. 100, § 199; p. 281, § 450 *e.*
sympathetic, concurs with the nervous power in producing the function of remote sympathy, p. 101–103, § 201–204; p. 107, 108, § 227; p. 282–284, § 451–453; p. 290, 291, § 462–467; p. 323–332, § 500.
sympathetic develops the nervous power, p. 101, § 201; p. 107, § 227.
common and *specific* terminate in the brain, and end in exciting perception, p. 100, § 196, 199½; p. 101, § 201; p. 280–282, § 450 *c*–451 *b.*
common and *specific* require the exercise of perception, p. 124, § 241 *d;* p. 281, § 450 *e.*
sympathetic may terminate in any part of the nervous system, does not affect perception, but ends in exciting

Sensation—*continued.*
the nervous power, p. 101–103, § 201–204; p. 107, 108, § 227; p. 124, § 242; p. 281–287, § 451–459 *a;* p. 321, § 497; p. 323–332, § 500; p. 342, 343, § 515, 516 *d,* Nos. 3, 4; p. 349, § 520–522; p. 353, § 524 *d,* Nos. 4, 5, 6.
common and *specific* may result in the development of the nervous power by exciting the mental emotions along with perception, when the emotion develops the nervous power, or *sympathetic* may be in simultaneous operation through nerves of organic life, p. 101, § 201 *a;* p. 103, § 209; p. 341, § 514 *m.* See, also, PAIN, and MENTAL EMOTIONS.
sympathetic is appropriated exclusively to organic life in animals, since the nervous power operates upon irritability in developing motion, and mobility in its functions in animal life is only a modification of the same property in organic life, p. 89, § 188 *a;* p. 103, § 208; p. 110, § 233; p. 126, 127, § 258–260; p. 323–332, § 500; p. 349, § 519; p. 671, § 903. See, also, NERVOUS POWER.
common and *specific* depend mostly upon cerebro-spinal nerves, p. 101, 102, § 201.
sympathetic depends mostly upon the sensitive fibres of the ganglionic and pneumogastric nerves, p. 102, § 201 *c.*
sympathetic is necessary to reflected motion, but never operates when motion is generated by causes acting directly upon the nervous system, p. 101, § 201; p. 107, 108, § 227; p. 671, § 903, and *ut cit.*
what is its chemical *rationale* in connection with *Perception* and Sympathy, p. 85, § 175 *c;* p. 155, § 349 *e;* p. 281, § 450; p. 329, 330, § 500 *n.*

SENSIBILITY,
peculiar to animals, p. 100, § 194.
"*organic*" is *irritability,* p. 99, § 193; p. 101, § 201 *a;* p. 671, § 903.
the great inlet of knowledge, p. 100, § 195; p. 281, § 450 *e.*
receives and transmits impressions, p. 46, § 74 *a;* p. 89, § 188 *b;* p. 93–96, § 188½ *d*–189 *c;* p. 100, § 195; p. 101–103, § 201–204; p. 281–283, § 450 *e*–451; p. 671, § 903.
its organs, the nerves, p. 100, § 196; p. 280, § 450 *b.*
is of three kinds, p. 100, § 196; p. 280, § 450 *a.*
common, belongs to all parts; the source of pain; generally dormant in organic life, but roused by disease, p. 100, § 198.

Sensibility—*continued.*
specific, peculiar to the senses; exquisitely susceptible, but rendered obtuse by disease, p. 100, § 199; p. 281, § 450 *e*.
common and *specific*, relative to the brain, or its equivalent, alone as their center; the sources of true sensation; require the exercise of perception, p. 89, § 188 *b*; p. 100, § 199½; p. 280, § 450.
sympathetic, an element of remote sympathy, p. 46, § 74 *a*; p. 89, § 188 *a*; p. 101–103, § 201–204; p. 104, § 209; p. 282–284, § 451 *c*–453; p. 671, § 903; is relative to the brain, spinal cord, and ganglionic system, as its centers, p. 101, 102, § 201; p. 287, § 459. See, also, SENSATION, *sympathetic may terminate*, &c.; effects of, reflected from nervous centers, p. 89, § 188 *a*; p. 101, § 201; p. 108, § 227; p. 223–232, § 500; necessary to reflected motion, *ibid*; resides especially in the sympathetic and pneumogastric nerves, p. 102, § 201 *c*; p. 104, § 209; does not involve true sensation or perception, p. 101, § 201 *b*; p. 103, § 204.
possesses modifications analogous to those of irritability, p. 100, § 200; p. 102, § 203; p. 108, § 227.
common, low in the nervous centers, p. 107, § 224.
less in trunks than nervous ramifications, p. 107, § 224; p. 347, § 516 *d*, No. 11; p. 521, § 826 *d*.
its general relations to external objects, p. 53, § 100; p. 398–400, § 626–630.
SEROUS TISSUE. See TISSUES.
SERUM. See INFLAMMATION.
SETON,
philosophy of its operation applied to the modus operandi of all morbific and remedial agents, p. 679–681.
SEX, p. 393–394.
SEXUAL ORGANS,
their relations to organic life, &c., p. 55, 56, § 118–121. See, also, YOUTH.
SLEEP,
how explained in materialism, p. 85, § 175 *c*; p. 329, 330, § 500 *n*.
awaking from disproves materialism, p. 85, § 175 *c*.
SODA, SULPHATE OF. See CATHARTICS, and THERAPEUTICS.
SODA, MURIATE OF. See ASTRINGENTS, and REMEDIAL ACTION.
SOLAR SPECTRUM,
physiologically and chemically applied, p. 92–95, § 188½ *d*; p. 115, § 234 *e*.
Solar Spectrum—*continued.*
its invisible rays, p. 91, § 188½ *d*; p. 115, § 234 *e*. See, also, ANALOGIES.
SOLIDISM,
the basis of medicine, p. 1, § 1. See, also, VITALISM AND SOLIDISM.
SOUL,
created after structure, p. 81, § 170 *a*.
a stimulus of the brain, p. 85, § 175 *c*.
that judgment, reflection, and perception, require, for their exercise, the co-operation of the brain, is analogically inferable from the manifest concurrence of the nervous system with the will in voluntary motion, p. 281, § 451 *a*. See, also, MIND, and NERVOUS POWER.
SOMNAMBULISM,
subjects of, between the sleeping and waking state; speech incoherent; rational faculty dormant; instinct mostly, but feebly, operative. See ANIMAL MAGNETISM, REASON, and INSTINCT.
"SPECIALITIES" IN MEDICINE,
not founded in philosophy, p. 687, § 905½ *b*; p. 721, 722, § 960 *c*, *d*.
SPECIFIC ACTION,
illustrated by remedial and morbific agents, p. 417, § 650; p. 424, § 662 *a*; p. 430, § 675, 676 *a*; p. 487–489, § 754–756; p. 542, § 854 *c*; p. 553, § 870 *aa*; p. 562, § 888 *c*; p. 587, § 892 *c*; p. 662–665, § 895–901; p. 676–679, § 904 *c*. See, also, ALTERATIVES, and ANALOGIES.
SPERMATOZOA,
the supposed germ, p. 42, § 67.
SPHINCTER MUSCLES,
held in contraction by the nervous power, p. 111, § 233½; p. 339, § 514 *g*.
illustrate the law of prolonged influence, *ibid*, and p. 344, 345, § 516 *d*, No. 6; p. 462, § 666; p. 670, § 902 *k*.
physiology of their contraction applied pathologically and therapeutically, *ibid*, and REMEDIAL ACTION.
SPINAL CORD,
its general physiological laws, p. 292–295, § 473–475.
SPONGE, BURNED, VEGETABLE ÆTHIOPS, and COD'S LIVER OIL, p. 619, § 892½.
SPONTANEOUS GENERATION. See GENERATION, SPONTANEOUS.
SQUILL. See EXPECTORANTS, THERAPEUTICS, EMETICS, DIURETICS, and REMEDIAL ACTION.
STETHOSCOPE,
its advantages, p. 640, § 892⅘ *h*.
STIMULANTS,
their uses, &c., p. 579–583.
STIMULI, VITAL, p. 21, § 21; p. 62, § 136, 137; p. 90, § 188½.
every part has its own, p. 62, § 136.

Stimuli, Vital—*continued.*
of one part offensive to other parts, p. 63, § 137.
certain natural ones acted upon and appropriated to various uses, p. 90, § 188½ *c;* p. 107–111, § 226–233¾.
their adaptation to parts, p. 62, § 136; p. 63, § 137 *c.* See, also, VITAL AGENTS, and ANALOGIES.

STOMACH,
alone generates a digestive fluid, p. 62, § 135 *a;* p. 191, 192, § 353; p. 229, § 419.
induction from, of the vital nature of decarbonization of the blood, p. 229, 230, § 419, 420. See, also, CARBON, and MUCOUS TISSUE.
its peculiar product artificially prepared, p. 197–202, § 362–376½.
its variety of structure and comprehensive relations in the function of assimilation, p. 140–147, § 305–330.
formative not destructive, p. 15, § 13, 14; p. 16, § 16–18; p. 24, § 42; p. 30, § 59; p. 33, § 60; p. 135, § 301; p. 143, § 322; p. 196, § 360, 361; p. 200, § 374, 375.
chemical theory of its function of digestion, p. 167–170, § 350, Nos. 29–34; p. 197–199, § 362–364½.
its usual unaltered state after death, adverse to the chemical theory of digestion, *ut supra.*

STORY,
his opinion of the times, p. 203–207, § 376¾ *a.*

STRAMONIUM. See ACONITE, &C.

STRENGTH AND WEAKNESS, OR DEBILITY, in what they consist, p. 370–372, § 569; p. 312, 313, § 487 *g, h.*

STRUCTURE,
its physical and vital characteristics, p. 50–73, § 83–163.
important to be known in its sensible and functional character, p. 51, § 83 *c.*
its minuteness, unimportant to know, p. 59, 60, § 131.
composed of Tissues, p. 52, § 85–88. See, also, TISSUES.
its vital characteristics, p. 52–73. See, also, TISSUES.
in plants and animals, how different, p. 54, 55, § 107–117; p. 134–140, § 293–304. See, also, PLANTS.
of organic beings, heterogeneous, p. 20, § 29.
its ultimate intricacy, p. 59, § 130.
created before life, p. 81, § 170.

STRYCHNIA,
effects on the nervous system, see ACONITE, &C.

SUDORIFICS,
the term objectionable, p. 250, 251, § 441 *c;* p. 335–341, § 512–514; p. 547, § 863 *d;* p. 550, § 863 *e;* p. 621,

Sudorifics—*continued.*
§ 892¾ *b;* p. 661–664, § 894–900; p. 666–669, § 902 *b, i;* p. 678, § 904 *d,* &c.; p. 704, § 943 *a, b,* 944 *a.*
many agents, like hot water, &c., may induce far greater diaphoresis than the antimonials and ipecacuanha; the former excite the circulation, the latter, like loss of blood, depress it, and perspiration is in proportion; the former of no useful effect or injurious, the latter profoundly curative, *ibid.* See, also, REMEDIAL ACTION, and ALTERATIVES.
the author's philosophy of their operation places the phenomena of petechial effusions of blood under the skin during the operation of emetics upon physiological grounds, as it does, in the same way, the supposed miracle, implied by the expression, "*and his sweat was, as it were, great drops of blood falling down to the ground.*" In this case the emotions were peculiar and violent, and operated in their compound aspect, according to the explanations which occur at p. 631, § 892¾ *b,* and *ut supra.* See, also, NERVOUS POWER, MENTAL EMOTIONS, ANALOGIES, CAPILLARIES, EMETICS, and SWEAT. Also, other facts and illustrations relative to the secretion of blood by the skin, piamater, &c., in *Medical and Physiological Commentaries,* vol. i., p. 371–384 (*pathology of spontaneous hemorrhage*); p. 683–690, (*endosmose and exdosmose*); vol. ii., p. 546–566, (*philosophy of spontaneous hemorrhage.*)

SUPPURATION,
a result of inflammation, instituted for great final causes, p. 471–474, § 730–733; p. 546–551, § 862, 863.
variable according to the exact condition of pathological states, p. 478–480, § 740, 741; p. 484, § 748; p. 536–539, § 847 *c*–848.
occurs, in a special product, upon mucous surfaces without ulceration, and farther illustrative of final causes, p. 472, § 733 *a.*

SWEAT,
an excreted product, p. 230, § 420–422.
considered in its relation to disease, p. 451, 452; and to physiological influences, see SUDORIFICS, and EXCRETION.
coincidence between, and mucus and carbon, as products of organization, p. 230, § 420. See, also, MUCOUS TISSUE.

SYMPATHETIC INFLUENCES,
laws of, p. 55, § 113, 115, 117; p. 56, § 120, 124; p. 57, § 125; p. 58, 59,

Sympathetic Influences—*continued*.
§ 129; p. 63–66, § 137–143; p. 67, 68, § 149–152; p. 106–111, § 222–233¾; p. 321–341, § 495–514; p. 405–412, § 638; p. 661–689, § 894–905½; p. 692, 693, § 914–921; p. 698, 699, § 929–935; p. 702–711, § 939–952; p. 746, § 990½ *a*. See, also, Sympathy.
depend, in part, upon the nature of tissues, p. 64, § 140–142; p. 67, § 150–152; p. 73, § 163. See, also, Tissues.

Sympathetic Nerve,
pervades all parts, p. 54, 55, § 111, 113; p. 58, § 129; p. 284–289, § 454–461½.
its ganglia to be regarded as analogous to brain, especially in inferior animals, and as contributing to generate the nervous power in the higher orders, p. 55, § 113; p. 321, § 497; p. 346, § 516 *d*, Nos. 8, 9; p. 349, 350, § 520–523; p. 353, § 524 *d*.
its prolongation through the chain of ganglia consists truly of communicating branches; thus making the ganglia so many intimately connected centers of sympathy; *ibid*, &c.
its ganglia are greatly the medium of contiguous sympathy, and more or less of remote, in the higher animals, p. 223, § 499; p. 349, § 520; p. 353, § 524 *d*;—the only centers of sympathy in the inferior animals, *ut cit*, &c.;—shown to be centers of sympathy by their resemblance to brain;—shown by the ramifications, and the interchanges of their nerves;—shown by the absence of brain and spinal cord in all but the higher animals; *ut cit*, and *passim*.
not necessary to organic life, as nutrition in the fœtus requires not the action of the compound organs; is said to have been absent in the fœtus, along with the brain and spinal cord, but is probably indispensable in the *anencephalus* to the action of the sphincters, p. 284–287, § 454–458; p. 289, § 461½ *a*; p. 338, 339, § 514 *f*, *g*. See, also, Nerves, Capillaries, Plants, and Organic Life.
appreciated by a few only, p. 112 § 234 *b*. See Ganglionic System.

Sympathetic Relations,
such as are natural, p. 58, § 129; p. 63, § 137.
morbid, p. 59, § 129 *i*; p. 64–66, § 140–143, 147. See, also, Adaptation, Law of.

Sympathies, Morbid,
of the Individual Tissues; see Tissues.
of the Compound Organs; See Organs, Compound.

Sympathy,
its general consideration, p. 283–362, § 452–530.
of three kinds, *continuous*, *contiguous*, and *remote*, p. 321–335, § 495–511.
contiguous and *remote* depend upon the nervous power, operating in its connection with *sympathetic sensibility*, *ibid*. See, also, Nervous Power, and Sensibility, *sympathetic*.
continuous, common to plants and animals, p. 322, 323, § 498; p. 351, § 524 *a*, No. 2.
its main centers, in the higher animals, the brain and spinal cord, p. 323, § 499. See, also, Sympathetic Nerve, and Nervous Power.
its physiological laws well settled, p. 111, § 234 *a*.
not applied pathologically or therapeutically, p. 111, § 234 *a*. See, also, Humoralism, and Organic Chemistry.
its natural conditions neglected or ridiculed, p. 111, § 234 *b*; p. 283, § 452 *b*.
how far expounded by the *Author*; see Nervous Power, *the Philosophy of its Operation*, &c.
admitted Laws of, and their application, by the *Author*, to pathology and therapeutics, p. 335–353, § 512–524.
physiological Laws of, luminously expounded by the great Prussian Physiologist, p. 341, § 514½ *b*; p. 362, § 530.

Symptoms,
the index of disease, p. 434–445.
certain special ones, p. 442–445.
mode of investigating, p. 430–433, § 675, 676 *a*; p. 437–442, § 685, 686; p. 561, § 888 *a*.

Syncope,
produced, not as supposed, by deficiency of blood at the center of the circulation, or by privation of nervous influence, but by a strong determination of the nervous power upon all the organs of circulation; *reproduced* by the antecedent enfeebled action of those organs, p. 304, 305, § 481 *g*, *h*; p. 703–709, § 940–951.
removed by the action of the nervous power, or by irritating the heart mechanically, p. 89, § 188 *a*; p. 107, 108, § 226, 227; p. 705, § 945.

T.

Tables,
of Organs according to their relative functions, p. 57, § 125.
of Tissues in their order of liability to inflammation, p. 70, 71.
of Tissues as to force of disease, p. 72.
of Tissues inflamed, as to treatment, p. 72, 73.

Tables—*continued.*
of the fluid products of secretion, p. 218, § 406.
TEMPERAMENT,
physiological, pathological, and therapeutical considerations relative to, p. 383–391, § 585–603. Five, the *sanguine, melancholic, choleric, phlegmatic*, and *nervous, ibid.*
philosophy of, shown by impregnation, p. 48, § 76; p. 49, § 80.
THEORIES, RIVAL,
should be compared and contrasted, p. 6–8, § 4½, 5; p. 19, § 18 *e;* p. 131–133, § 281–295; p. 157–173, § 350; p. 189, 190, § 350¾ *n;* p. 191, § 351; p. 208–217, § 382–399; p. 219–227, § 408–411; p. 238, § 438; p. 246, § 440 *f;* p. 277, 278, § 447½ *f;* p. 433, 434, § 676 *b;* p. 456, 457, § 699; p. 463, § 709; p. 482, § 744; p. 484, § 748; p. 499, § 785; p. 500–504, § 786–797; p. 514, § 819 *a*, Nos. 1–7; p. 662, § 896, &c.; p. 690, § 906 *f;* p. 691, § 908–910.
THEORY,
natural to the mind, p. 5, § 4 *a;* p. 10, § 5¼ *c.*
inculcated by the Creator, p. 5, § 4 *a.*
founded in Nature, p. 5, § 4 *a.*
implies the greatest reference to facts, p. 5, § 4 *b.*
should be studiously considered, p. 5, § 4 *b;* p. 10, § 5¼ *c.*
undervalued by the ignorant alone, p. 5, § 4 *b.*
true, or *false*, always guides the ignorant practitioner, p. 5, § 4 *b.*
how to make one, p. 10, § 5¼ *b, c.*
THERAPEUTICS,
considered in its various aspects, p. 541–777, § 852–1027.
the chemical system of, p. 176–178, § 350¾.
THOUGHT,
chemical theory of, p. 155, § 349 *e;* and corresponds with the chemical theory of *delirium* and *mania*, p. 243, § 440 *c.*
TIME,
the arbiter of right, p. 622, § 892¾ *b.*
TISSUES,
of the animal body, p. 52, § 86.
their individuality important, p. 52, § 88; p. 61, § 133; p. 70, § 162; p. 416, § 649 *b–d.* See, also, VENOUS TISSUE.
their distinctions physical and vital, p. 52, § 89; p. 61–73, § 133–163.
their union, p. 52, § 89–92.
a knowledge of important in medicine, p. 50, § 83; p. 61, § 132–134; p. 67, § 149–152; p. 69–73, § 160–163; p. 353–362, § 525–530; p. 468, § 722 *c.*
their respective modifications of life,

Tissues—*continued.*
p. 61–64, § 133–138; p. 64, § 142; p. 416, 417, § 649 *b–d.*
their special products, p. 62, § 135; p. 141, § 307.
their special stimuli, p. 45, § 73; p. 62, § 136; p. 92–95, § 188½ *d.*
their relative liability to disease, p. 70–72, § 162.
their relative force of disease, p. 72, § 162.
inflamed, their relative demands for bloodletting, p. 72, § 162.
TISSUES, SYMPATHIES OF,
of the individual, p. 353–361.
of similar, p. 353–358.
of dissimilar, p. 359, 360.
of individual in their relation to each other in Compound Organs, and with Entire Organs, p. 360, 361.
TOBACCO,
on the one hand, and *Lobelia* on the other, "tried somewhat extensively as substitutes for bloodletting in inflammatory affections," p. 715–718, § 960 *a, g;* p. 515, § 819 *b;* p. 527, § 829; p. 529, § 835; p. 540, § 851.
exemplifies the laws of *vital habit*, p. 364, § 542–548½; p. 718, § 960 *a, note.*
its use unwarrantable in strangulated hernia, p. 716–718, § 960 *a.*
its limited use as a luxury admissible in health only, p. 718, § 960 *a, note.*
TONGUE,
as supplying symptoms, p. 448–450.
TONICS,
general consideration of their uses, mode of operating, &c., p. 579–583.
TRUTH,
how best ascertained and established, p. 2, § 2 *b;* p. 238, § 438 *d;* p. 463, § 709; p. 515, § 819 *b.* See, also, ERROR, and FACTS.
its compass and nature, p. 11, § 5¼ *c.*
its fundamental distinction from error, p. 166, § 350, No. 28; p. 157–173, 189, 190.
can be sustained by itself alone, *ibid.*
man's ultimate love of, his greatest approximation to his Maker, p. 124, § 241 *c.*
TUBES,
organic and *inorganic*, have no resemblances in structure or function, p. 99, § 192; p. 318, § 493 *d.*

U.

ULCERATION,
its pathological character, &c., p. 470, 471, § 729 *a, b;* p. 472–475, § 733; p. 477, § 736 *c*, 737; p. 478, § 740 *a.*
UNDERSTANDING,
a property of the mind and of the instinctive principle, p. 123, § 241 *b* See MIND.

UNITY OF DESIGN. See DESIGN.

UREA,
its importance in organic chemistry, p. 228, § 417.

URINARY AGENTS,
their general uses, influences, &c., considered, p. 683–689. See, also, DIURETICS.

URINARY ORGANS,
product of, inorganic matter, p. 228, § 417 *a*.
contribute, by depurating the blood, to the process of assimilation, p. 330, § 421.
remarkable sympathy between, and the skin, p. 330–332, § 422–424. See, also, NERVOUS POWER.
product of, very variable in health and disease, p. 232, 233, § 425–427.
but little subject to disease, p. 450, 451, § 691.
adaptations to, of urinary agents, p. 683–689, § 905½.

URINE,
its relations to disease, p. 450, § 691.
its spontaneous transformations occur as readily as those of blood, p. 228, § 417, &c.
morbid states of, sufficiently recognized by inspection, p. 233, § 427; p. 451, § 691.

UTERINE AGENTS,
considered in their various therapeutical aspects, p. 683–689. See, also, EMMENAGOGUES, and ERGOT.

UVA-URSI. See GENITO-URINARY AGENTS.

V.

VEGETABLE KINGDOM,
essentially independent of the animal, p. 16, § 16, 17; p. 135–138, § 300–303½. See, also, PLANTS, and ORGANIC LIFE.
its importance to animals, p. 15, § 11–14; p. 16, § 16; p. 135–138, § 300–303½.

VEINS,
their ordained function in respect to the circulation, their peculiar vital constitution, their one and peculiar vital stimulus, their extreme liability to irritation and inflammation, as well as direct observation, prove that they take no part in the function of absorption, p. 62, § 136; p. 63, § 137 *b, c*; p. 128–134, § 269–295; p. 210, § 387; p. 527, § 829. See, also, ABSORPTION, VENOUS TISSUE, CIRCULATION VENOUS, and VENOUS CONGESTION.
function of their valves explained, p. 212, § 391.

VENOUS CONGESTION,
inquiry into its pathology, philosophy, influences, treatment, &c., p. 500–513, § 786–818; p. 724–732, § 961–970; p. 756–759, § 1005.
constituted, essentially, by inflammation of the venous tissue, p. 503, § 794, 795.
coincident in its pathology with that of phlebitis and varix, p. 503, 504, § 796, 797.
its influences upon the system different from those of inflammation of other tissues, p. 507, 508, § 806; p. 724–726, § 961 *a–e*.
modifies the phenomena of idiopathic fever and of other inflammatory affections, and increases their danger, p. 508, 509, § 809–811; p. 511, § 815, 816; p. 725, § 961 *b*.
insidious, p. 508, 509, § 806–810; p. 724, § 961 *a*; p. 756–759, § 1005 *a–h*.
its prostration of the functions of animal life mistaken for "debility" of organic life, p. 726, § 961 *b*. See, also, WILL.
illustrates the sway of theory in the treatment of disease, p. 500, § 789; p. 501, § 790 *b*; p. 729, § 967; p. 4, 5, § 4 *a, b*. See VENOUS TISSUE.

VENOUS TISSUE,
author's exposition of the peculiarities of its vital constitution, and of their bearing upon venous circulation, and upon the pathology and treatment of phlebitis, venous congestion, and varix, and, also, of the influences of its pathological conditions upon the system at large, and upon coexisting membranous inflammations, and upon idiopathic fever, p. 62, § 136; p. 63, § 137 *e*; p. 64, § 140, 141 *a*; p. 67, § 149–151; p. 73, § 163; p. 209–212, § 387–390; p. 214, § 392 *d*, 393; p. 352, § 524 *d*; p. 353, § 525 *a*; p. 354, 355, § 526 *b*; p. 416, § 649 *b, c*; p. 424, 425, § 662 *b, c*; p. 440, 441, § 686 *b*; p. 444, 445, § 688 *c, e*; p. 447, 448, § 688 *i, k*; p. 450, § 689 *b*; p. 453–455, § 694, 694½; p. 468, § 722 *c*; p. 500–513, § 786–818; p. 724–732, § 961–970; p. 735, § 978; p. 756–762, § 1005.

VIS MEDICATRIX NATURÆ,
what it is, and what its advantages, p. 87, § 177; p. 122, § 239, 240; p. 457, § 699 *c*; p. 470–475, § 729–733 *f*; p. 476, § 735 *a*; p. 489, § 757 *a*, p. 492, 493, § 764 *b, c*; p. 497, § 775; p. 498, 499, § 784, 785; p. 531, § 839; p. 536, § 847 *a*; p. 541, § 853; p. 542, § 854 *e*; p. 543–551, § 855–864; p. 558, § 878; p. 662–664, § 895–899; p. 683, § 905 *b*.
not recognized in the chemical and humoral pathology, p. 169–173, §

Vis Medicatrix Naturæ—*continued.*
350, Nos. 36–46; p. 176–178, § 350⅝; p. 540, § 851 *a*; p. 550, § 863 *e*; p. 661, *mottoes*.
does not *institute*, nor carry on, the recuperative process *in the blood*, p. 535, 536, § 847 *a–c*; p. 546, § 863 *a*.
Vis Inertiæ,
takes the place of *Vis Vitæ*, p. 30, 31, § 59; p. 105, § 216.
Vision,
vital and Chemical Theories of, p. 92–95, § 188½ *d*.
Vital Affinity,
a property of the Vital Principle, and common to plants and animals, p. 88, § 183, 184 *a*.
unites the elements of organic compounds by associate action with the other organic properties, p. 42, 43, § 67, 68; p. 89, § 187, 188; p. 104, § 212; p. 105, § 217, 218; p. 135, § 299.
modified in plants and animals, p. 88, § 185; p. 105, § 217.
susceptible of morbid changes, p. 47, 48, § 75, 76, 78; p. 105, § 220; p. 146. 147, § 327–331; p. 535, 536, § 846, 847.
its morbid changes illustrated by, and analogous to, its progressive natural modifications from the ovum to old age, and such as result from the slow influences of climate, cultivation, &c., p. 42, 43, § 67, 68–70; p. 48, § 77; p. 68, 69, § 153–159; p. 363, § 538; p. 364, § 548; p. 369, § 562; p. 376–380, § 578.
how opposed to *chemical affinity*, p. 30–33, § 59, 60.
Vital Agents,
whatever acts upon life, p. 21, § 21; p. 45, § 73; p. 46, § 74; p. 62, 63, § 136, 137; p. 90–95, § 188f; &c.
act upon *irritability* in generating all sensible and insensible motions, and upon *sensibility* in the function of sensation and in the transmission of all influences from remote parts to the nervous centers, whether relative to animal or to organic life, p. 21, § 21; p. 45, § 73; p. 46, § 74; p. 86, § 175 *d*; p. 89, § 188; p. 95–102, § 189–203; p. 107–111, § 226–233¾; p. 112, § 234 *c*; p. 114, § 234 *e*; p. 119, § 234 *i*; p. 280–283, § 450–451; p. 284–287, § 454–458; p. 289, § 461; p. 296, § 476 *c*; p. 313, § 487 *h*; p. 323–341, § 500–514; p. 398–400, § 626–630; p. 405–412, § 638; p. 661–664, § 894–901; p. 692, 693, § 915, 920; p. 698, § 929–934; p. 707, § 949; p. 726, § 961; p. 732, § 973; p. 746, § 990½ *a*. See, also, Analogies.
philosophy of their operation, p. 47–49,

Vital Agents—*continued.*
§ 73–80; p. 89, § 188; p. 90–99, § 188½–193; p. 106–111, § 223–233¾; p. 296, § 476 *c*; p. 313, § 478 *h*; p. 321–335, § 495–511; p. 661–664, § 894–901; p. 692, 693, § 915, 920. See, also, Remedial Action.
internal and external, p. 21, § 21; p. 45, § 73; p. 62, § 136; p. 90, § 188½; p. 106, 107, § 223, 226; p. 110, 111, § 233, 233¾; p. 296, § 476 *c*; p. 313, § 487 *h*; p. 398–400, § 626–630; p. 405–412, § 638.
how necessary to life, p. 21, § 21; p. 30, § 57; p. 45, § 73; p. 46, § 74 *a*; p. 62, § 136; p. 63, § 137 *d*, *e*; p. 65, § 143 *c*; p. 67, § 150, 151; p. 90, § 188½; p. 106, 107, § 223, 226; p. 110, § 233; p. 285, § 455 *c*; p. 398–400, § 626–630.
act and acted upon, p. 21, § 25; p. 24, § 42; p. 90, § 188 *c*; p. 108–110, § 227–232; p. 134–144, § 296–322; p. 227, § 411.
do not act upon the structure, p. 95–97, § 189; p. 107–111, § 226–233¾; p. 112, § 234 *c*; p. 282, § 451 *b*; p. 330, § 500 *n*; p. 746, § 990½ *a*
their action conforms to the *kind* of irritability and sensibility, p. 43–47, § 70–74; p. 62–69, § 136–156; p. 97–103, § 190–204; p. 109, § 229; p. 110, § 233; p. 399, § 628, 630; p. 662–664, § 895–900.
include the morbific, p. 90, § 188½ *b*, *and as above*. See, also, Analogies.
their most comprehensive relations to organic states, p. 21, § 21; p. 67, 68, § 149–152; p. 120–122, § 237–240; p. 398–400, § 626–630; p. 405–412, § 638; p. 662–665, § 895–901.
their relations to life affected by disease, p. 3, § 2 *b*; p. 47–49, § 75–79; p. 59, § 129 *g–i*; p. 61, § 133 *c*; p. 63–68, § 137 *c*–152; p. 73, § 163; p. 98, § 191; p. 108, 109, § 227–230; p. 120–122, § 237–240. See, also, Remedial Action, Therapeutics, *general*, and Adaptation, Law of.
analogies between the physical and moral, p. 111, § 233¾; p. 296, § 476 *c*; p. 313, § 487 *h*; 323–332, § 500; p. 662–665, § 895–901. See, also, Analogies.
each one has special virtues and exerts special influences, p. 21, § 21, 25; p. 30, § 57; p. 45–49, § 73–80; p. 62–64, § 135–140; p. 65–68, § 143 *c*–152; p. 73, § 163; p. 87, § 179; p. 90, § 188½ *a–c*; p. 92–95, § 188½ *d*; p. 98, § 191; p. 100, § 198, 199; p. 101–103, § 201–204; p. 104, § 215; p. 107–111, § 226–233¾; p. 119, § 235; p. 417, § 650; p. 662–665, § 895–901. See, also, Remote Causes of Dis-

Vital Agents—*continued.*
EASE, THERAPEUTICS, and VITAL HABIT.

VITAL FORCE, CHEMICAL THEORY OF. See ORGANIC FORCE, CHEMICAL THEORY OF.

VITAL FUNCTIONS,
experiments to Determine their Laws, and their application *by the Author* to physiology, pathology, and therapeutics, p. 290–321, ◊ 462–494.

VITAL HABIT,
its laws and phenomena, physiological and moral, p. 363–370, ◊ 535–568.

VITAL PRINCIPLE,
has various properties, p. 83, ◊ 175; p. 88, ◊ 183, 184. See, also, VITAL PROPERTIES.
has remarkable analogies with the soul, and with the principle of instinct, p. 84, ◊ 175 *b;* p. 281, 282, ◊ 451.
illustrated by light, &c., p. 79, ◊ 168; p. 84, ◊ 175 *b;* p. 114, 115, ◊ 234, *e, f;* p. 330, ◊ 500 *n.*
a whole, p. 41, 42, ◊ 65–67; p. 56, ◊ 122; p. 82, ◊ 171; p. 97, ◊ 190 *b;* p. 435, ◊ 680.
recognized at all ages, p. 73, ◊ 164.
recognized by all who deny its existence, p. 6, 7, ◊ 4½ *b, d;* p. 19, ◊ 18 *e;* p. 30–33, ◊ 59, 60; p. 38–40, ◊ 64 *e–h;* p. 95, 96, ◊ 189 *b;* p. 157–173, ◊ 350; p. 189, 190, ◊ 350¾ *n.*
history of its vicissitudes with medical philosophers, p. 73–79, ◊ 164–168.
opinions respecting, p. 24, ◊ 42; p. 37–41, ◊ 64, 65; p. 74–79, ◊ 165–167; p. 132, 133, ◊ 289, 290; p. 149–155, ◊ 337–349; p. 157–173, ◊ 350; p. 189, 190, ◊ 350¾ *n;* p. 514, ◊ 819 *a.*
its existence and laws variously attested, and by adequate phenomena, p. 36–49, ◊ 63–80; p. 75, ◊ 165 *b;* p. 80, ◊ 169; p. 84, ◊ 175 *bb;* p. 111–122, ◊ 234–240; p. 182, ◊ 350¾ *g;* p. 330, ◊ 500 *n.*
shown by elementary composition, p. 15, ◊ 10–14; p. 16, ◊ 16, 17; p. 20–49, ◊ 19–80; p. 79, ◊ 167 *g.*
proved by nitrogen gas, p. 34–36, ◊ 62.
proved by its phenomena, p. 75, ◊ 165 *b;* p. 79, ◊ 168; p. 80, ◊ 169; p. 84, ◊ 175 *bb.*
proved by the function of appropriation, p. 24, 25, ◊ 41–43; p. 227, ◊ 411.
proved by the nervous power, p. 106–111, ◊ 223–233¾; p. 323–332, ◊ 500; p. 746, ◊ 990½ *b.*
proved by universal consent; see above, *recognized by all who deny its existence.*
its nature unknown, as of all things else, p. 79, ◊ 168; p. 117, ◊ 234 *g;* p. 152, ◊ 345; p. 428, 429, ◊ 674 *a;* p. 499, ◊ 785.

Vital Principle—*continued.*
inseparable from living organic matter, p. 81, ◊ 170; p. 96, ◊ 189 *c.*
created after structure, p. 81, ◊ 170.
and organic matter mutually dependent, p. 81, ◊ 170; p. 96, ◊ 189 *c.*
indivisible, p. 82, ◊ 171.
summary definition of its characteristics, p. 82, ◊ 172.
fundamental cause of all phenomena of organic beings, p. 24, ◊ 42; p. 30–49, ◊ 57–81; p. 73, ◊ 164; p. 96, ◊ 189 *c;* p. 115, ◊ 234 *e;* p. 157–173, ◊ 350, Nos. 47–97; p. 435, ◊ 680; p. 662–664, ◊ 895–900, *and so on.*
combines the elements of matter in plants, p. 15, ◊ 11, 13; p. 30, ◊ 58; p. 83, ◊ 173; p. 135–139, ◊ 298–303⅔. See, also, PLANTS.
modifies and appropriates organic compounds in animals, p. 15, ◊ 11, 14 *a;* p. 83, ◊ 173; p. 143, 144, ◊ 322; p. 196, ◊ 360, 361.
re-arranges the elements of organic compounds, p. 24, 25, ◊ 40–45; p. 30, ◊ 58; p. 40–49, ◊ 65–80; p. 150, ◊ 339 *a, b;* p. 152, 153, ◊ 345–349 *a;* p. 227, ◊ 411.
essentially the same in plants and animals, p. 88, ◊ 185. See, also, PLANTS, and ORGANIC LIFE.
on a par with magnetism and light, p. 75, ◊ 165 *b;* p. 79, ◊ 168; p. 80, ◊ 169 *b;* p. 81, ◊ 170 *a;* p. 84, ◊ 175 *bb;* p. 99, ◊ 191 *d;* p. 112–120, ◊ 234 *c*–237; p. 330, ◊ 500 *n;* p. 746, ◊ 990½ *b.*
how far creative, p. 25, ◊ 43; p. 37–40, ◊ 64 *c–h;* p. 81, ◊ 170; p. 82, 83, ◊ 172; p. 149, ◊ 336; p. 169, ◊ 350, No. 84; p. 227, ◊ 411. See, also, NATURE, *contradistinguished from Creative Power.*
resists chemical agencies, p. 30–33, ◊ 57–60; p. 194, ◊ 358; p. 196, ◊ 360. See, also, DIGESTION.
the source of growth, p. 30, ◊ 57; p. 36–44, ◊ 63–72; p. 227, ◊ 411; p. 435, ◊ 680. See, also, PLANTS.
develops the germ, p. 36–49, ◊ 63–81; p. 97, ◊ 190 *b.*
strongly pronounced in the ovum, p. 42, ◊ 67; p. 44, ◊ 71; p. 97, ◊ 190 *b.*
laws of, deduced from the ovum, p. 30, ◊ 57, 58; p. 36–49, ◊ 63–81; p. 97, ◊ 190 *b.*
presides over organic processes and results, p. 30, ◊ 58; p. 31–32, ◊ 59; p. 37–49, ◊ 64–80; p. 148–154, ◊ 335–349 *c;* p. 196, 197, ◊ 360, 361; p. 227, ◊ 411; p. 273, ◊ 447 *h;* p. 405-412, ◊ 638; p. 435, ◊ 680; p. 474, 475, ◊ 733 *f–i;* p. 662–664, ◊ 895-900.
makes no demands on chemistry, p

Vital Principle—*continued.*
15, § 13, 14; p. 16, § 16–18; p. 24, § 42; p. 30–33, § 59, 60; p. 42, § 66, 67; p. 44, § 71; p. 84, § 175 *bb*; p. 135, § 301; p. 143, § 322; p. 194, 195, § 358, 359; p. 196, 197, § 360, 361; p. 201, § 374, 375; p. 203, § 376½; p. 227, § 411; p. 276–279, § 447½ *f*; p. 376–380, § 578; p. 405–412, § 638; p. 160–162, § 350, Nos. 58–61.
generates Motion, and variously, p. 21, § 24; p. 31, § 59; p. 37–49, § 64–80; p. 86, 87, § 176, 177; p. 103, § 205, 208, 209; p. 107–111, § 226–233¾; p. 323–332, § 500; p. 746, § 990½ *a*.
mutable in its nature; see Vital Properties.
its mutability the fundamental cause of disease and its cure; see Vital Properties.
its mutability designed for useful purposes; see Vital Properties.
formative not destructive, p. 16, § 16–18; p. 83, § 172; p. 135, § 301; p. 196, § 360; p. 227, § 411.
its nature altered in man since his Creation, which proves the Mosaic statement, p. 401, § 632.
subject to extinction, p. 11, § 5¼ *e*; p. 30, 31, § 58, 59; p. 83, § 174; p. 87, § 176; p. 96, § 189 *b, c*; p. 189, 190, § 350 *n*; p. 401, § 631.
by its formative action its own destroyer, p. 382, 383, § 581–584; p. 401, 402, § 633.
a bond of union between mind and matter, p. 116, 117, § 234 *f*.
considered identical with the chemical forces, p. 154, § 349 *c*; p. 180–182, § 350¾ *e–gg*; p. 189, 190, § 350¾ *n*. See, also, Vital Properties in the Elements of Matter, and Problems.

Vital Properties,
elements or properties of the Vital Principle, just as judgment, reflection, understanding, the will, &c., are properties of the soul, p. 88, § 183.
four are common to plants and animals, and are called *organic*, or *common*, viz., *irritability*, *mobility*, *vital affinity*, and *vivification*, p. 88, § 184; and two superadded to the life of animals along with the nervous system, and are called *peculiar*, viz., *sensibility* and the *nervous power*, p. 88, § 183–185. See, also, *the several Properties*.
the common or organic co-operate more or less together in organic processes, p. 42, 43, § 67, 68; p. 89, § 187, 188; p. 103, § 208, 209; p. 104, § 212; p. 105, § 217, 218; p. 135, § 299.
perform the functions which are ascribed, in a collective sense, to the Vital Principle, and individually as analyzed under each property; see *the several denominations*.
the *organic*, essentially the same in plants and animals, but specifically modified or varied in each, as known by coincidences in their composition, structure, susceptibility to the action of internal and external agents, growth and nutrition, and all their essential functions, and products, diseases, reparation, generation, &c., p. 15, § 9–14; p. 20–22, § 20–30; p. 23–25, § 34–45; p. 27, § 51–53; p. 28–45, § 54–73; p. 54–56, § 105–124; p. 68, § 155; p. 88, § 185; p. 89, § 188; p. 90, § 188½ *a–d*; p. 93–95, § 188½ *d*; p. 97, 98, § 190, 191; p. 99, § 192; p. 103–105, § 205–221; p. 118, § 234 *g*; p. 120, 121, § 236–238; p. 125, § 249; p. 127, 128, § 260–266; p. 134, § 293–295; p. 135–138, § 298–303½; p. 140, § 304; p. 163–167, § 350, Nos. 64–77, 26½, 27; p. 203, § 376½; p. 224–229, § 409 *g*–419 *a*; p. 260–263, § 445–446; p. 271–278, § 447 *f*–447½ *f*; p. 279, 280, § 449; p. 284, 285, § 454–455 *e*; p. 286, § 456 *a*; p. 322, 323, § 498; p. 398–400, § 626–630; p. 473–476, § 733 *e–k*.
possess natural modifications in different organs and tissues, and in the conditions of the ovum, p. 30, § 57; p. 43, § 70; p. 44, § 72; p. 46, § 74; p. 61–63, § 133–137; p. 64, § 138; p. 67–73, § 149–162; p. 82, § 172; p. 88, § 185; p. 97, 98, § 190, 191 *a*; p. 100, § 197–200; p. 102, § 203; p. 105, § 217; p. 114, § 234 *d*. See, also, Tissues, Venous Tissue, and Analogies.
their definite character and permanency, p. 87, § 178–182; p. 120–122, § 237–239; p. 181, 182, § 350¾ *f, g*; p. 662–665, § 895–901. See, also, Vis Medicatrix Naturæ.
mutable in their nature, p. 3, § 2 *b*; p. 11, § 5¼ *e*; p. 47–49, § 74–80; p. 61, § 133 *c*, 134; p. 68, 69, § 153–156; p. 87, § 176–182; p. 98, 99, § 191 *b*–192; p. 105, § 220; p. 107–110, § 225–232; p. 121, 122, § 237–240; p. 352, § 524 *d*; p. 376–380, § 578; p. 405–412, § 638; p. 417, § 650; p. 428, § 672; p. 435, § 680; p. 478, 479, § 740, 741; p. 662–664, § 896–900.
their mutability has corresponding changes in the properties of the

Vital Properties—*continued.*
mind and instinct, p. 98, § 191 *c;* p. 123, 124, § 241 *c;* p. 369, 370, § 564–568; p. 374, § 576 *b;* p. 376, § 577 *b;* p. 377, § 578 *c;* p. 380, 381, § 579; p. 382, § 581.
their natural modifications in different parts shown by natural stimuli, p. 46, § 74 *a;* p. 62, § 136; p. 97, § 190 *b*–191 *a;* p. 100, § 199, 201;—by natural products, p. 24, § 42; p. 50, § 83; p. 62, § 135; p. 97, § 190; p. 227, § 411; p. 229, § 419; p. 233, 234, § 428–432; p. 378, § 578 *c;*—by action of foreign agents, p. 61, § 134; p. 63, § 137; p. 67, § 149–151; p. 73, § 163; see, also, Remote Causes of Disease, Tissues, Venous Tissue, Therapeutics, &c.;—by organization, p. 64, § 141; p. 88, § 185; p. 100, 101, § 194–201; p. 106, § 223; p. 223–227, § 409–411;—by morbific causes, p. 64, § 142; p. 66, § 143; p. 67, § 149, 150; p. 68–73, § 153–162; p. 98, § 191; see, also, Remote Causes of Disease, &c.;—by the development of organs, p. 46, § 74; p. 68, 69, § 153–159; p. 87, § 178; p. 97, § 190 *b;* p. 375, § 577; p. 376–380, § 578;—by the ovum, p. 42–45, § 67–73; p. 97, § 190 *b;*—by comparison of plants and animals, p. 15, § 10–14; p. 16, § 16, 17; p. 20, § 18 *e;* p. 54, 55, § 107–117; p. 56, § 121–123; p. 88, § 185; p. 97, § 190 *b, c;* p. 135–140, § 298–305; p. 223–227, § 409 *e*–411; p. 474, 475, § 733 *f–i;*—by the variety of effects, p. 67, § 149–151; p. 120–122, § 226–240; p. 222–227, § 409 *c*–411; p. 474, 475, § 733 *f–i.*
their natural modifications in different species of beings, and in different parts, have important final causes, p. 15, § 9–14; p. 30, § 57; p. 42–46, § 66–74; p. 61, § 133 *b;* p. 62, § 135, 136; p. 65, § 143 *c;* p. 67–69, § 150–156; p. 87, § 180; p. 88, § 185; p. 93, 95, § 188½; p. 97, 98, § 190 *b*–191 *a;* p. 99, § 192; p. 100–102, § 199–203; p. 104, § 212, 214; p. 105, § 217; p. 352 § 524 *d;* p. 375, 376, § 577 *b;* p. 376–381, § 578–579.
their mutability designed for useful purposes, p. 3, § 2 *b;* p. 61, § 133 *c;* p. 63, § 137 *e;* p. 68, 69, § 153–156; p. 87, § 180; p. 120, § 237; p. 352, § 524 *d;* p. 376, § 578 *b;* p. 378, § 578 *c;* p. 435, § 680; p. 662, § 895.
their mutability the fundamental cause of disease, p. 3, § 2 *b;* p. 11, 5¼ *e;* p. 47–49, § 74–80; p. 61, § 133 *c;* p. 87, § 177–182; p. 98, § 191; p. 121, § 237, 238; p. 352, § 524 *d;* p. 662–664, § 895–900.

Vital Properties—*continued.*
their mutability the ground-work of cure, p. 61, § 133 *e;* p. 89, § 177–179; p. 119, § 234 *i;* p. 122, § 239; p. 428, § 672; p. 544, 545, § 858; p. 546–551, § 862–864; p. 662–664, § 895–900.
their mutability the great cause of difficulties in medicine, p. 120, 121, § 237; p. 662, § 895; p. 664, § 899.
subject to extinction; see Vital Principle, *subject to,* &c.
a knowledge of their modifications, natural and morbid, contrasted with a knowledge of the undulations of light, &c., p. 115, 116, § 234 *f.* See, also, Adaptation, Law of.
"Vital Properties in the Elements of Matter,"
disproved, p. 16, § 14 *c.*
how they are supposed to create man, and other organic beings, p. 86, § 175 *d;* p. 160, 161, 170, § 350, Nos. 12, 13, 39; p. 178–184, § 350¾ *a–g;* p. 186–192, § 350¾ *kk*–354.
supposed to animate *hydrogen, nitrogen, oxygen,* and *carbon,* and that these are the special elements, which, with the aid of heat, moisture, &c., create organic beings, p. 181, 182, § 350¾ *f.*
Vital Properties and Functions,
modifications of, arising from Age, Temperament, Constitution, Sex, Climate, Habit, &c., p. 373–397.
Vital Stimuli, Sedatives, and Alteratives. See Vital Agents, Alteratives, and Analogies.
Vitalism and Solidism,
the foundation of medicine, p. 1, § 1.
deduced from the seed and ovum, p. 30, § 57; p. 36–49, § 63–81; p. 56, § 121–123; p. 97, § 190 *b;* p. 279, 280, § 449.
their doctrines virtually conceded by their opponents, p. 19, § 18 *e;* p. 22, § 29; p. 30–33, § 57–60; p. 38–40, § 64 *e–h;* p. 95, 96, § 189 *b;* p. 152–154, § 345–349 *c;* p. 157–173, § 350; p. 189, 190, § 350¾ *n;* p. 191, § 351; p. 478, 479, § 740; p. 514, § 819 *a,* Nos. 4–7.
always consistent, p. 1, § 1; p. 40–49, § 65–81; p. 81, § 169 *f;* p. 94, 95, § 188½ *d;* p. 147, § 330, 333; p. 235, § 435 *a;* p. 331, § 500 *o;* p. 405–412, § 638; p. 413, § 639 *a;* p. 541, § 852; p. 662–665, § 895–901. See, also, Analogies, and Nervous Power.
admits of no unnecessary multiplication of causes, p. 81, § 169 *f;* p. 154, § 349 *b;* p. 194–197, § 358–361; p. 234, § 433; p. 264, 265, § 446 *c,* 447 *a, b;* p. 271, § 447 *f;* p. 276–278, § 447½ *f;* p. 331, § 500 *o;* p.

Vitalism and Solidism—*continued.*
405–412, § 638; p. 550, § 863 *e;* p. 662, § 895. See, also, ORGANIC CHEMISTRY AND PHYSIOLOGY CONTRASTED.
contradistinguished from *Humoralism,* p. 147, § 330; p. 516–518, § 821, 822; p. 535–540, § 846–851; p. 550, § 863 *e;* p. 662–664, § 895–900.
"VITALITY SEEN IN DEAD MATTER," p. 179, § 350¾ *c.* See, also, VITAL PROPERTIES IN THE ELEMENTS OF MATTER.

VIVIFICATION,
a property of the Vital Principle, and common to animals and plants, p. 88, § 183, 184 *a;* p. 105, 218–221.
with *vital affinity,* bestows life, p. 105, § 218.
belongs to the assimilating organs, and to their subsidiary fluids, p. 105, § 219.
liable to morbid changes, p. 105, § 220.

VOLUNTARY MOTION,
physiology of. See MOTION, WILL, NERVOUS POWER, and MUSCLES OF VOLUNTARY MOTION.

VOMITING,
physiology of, p. 666–669, § 902 *b–g.*

W.

WHITE VITRIOL, OR SULPHATE OF ZINC, its uses, &c. See ZINC SULPHATE, and REMEDIAL ACTION.

WILL, THE,
its relation to motion, p. 89, § 186, 188 *a;* p. 95, § 188½ *d;* p. 97, § 190 *a;* p. 104, § 215; p. 107, § 227; p. 110, 111, § 233, 233½; p. 113, § 234; p. 124, 125, § 243–246; p. 210, § 486; p. 282, § 451 *c;* p. 284, § 454; p. 288, § 459 *d, e;* p. 296, § 476 *c;* p. 313, § 487 *gg, h;* p. 314, § 488½; p. 324–328, § 500 *d–l;* p. 357, § 526 *d.*
presides in animal life, p. 124, § 243; p. 296, § 476 *c;* p. 313, § 487 *gg, h;* p. 314, § 488½; p. 327, 328, § 500 *k;* p. 357, § 526 *c.*
scarcely reaches to organic life, p. 124, § 243; p. 282, § 451 *c;* p. 284, 285, § 544–545 *c;* p. 296, § 476 *c;* p. 313, § 487 *gg, h;* p. 314, § 488½; p. 324–328, § 500 *d–l.*
has no operation after removal of the brain, p. 288, § 459 *d, e;* p. 324, § 500 *d;* p. 357, § 526 *d;* and has analogies to this in being wholly inoperative in paralysis, and more or less so in narcotization, and in its failure to act as usual upon the muscles of locomotion, or in protruding the tongue, in febrile diseases, and which is so often mistaken for "*debility,*" p. 296, § 476 *c;* p. 313, § 487 *gg, h;* p. 370–372, § 569; p. 481, § 743; p. 483, § 746 *c;* p. 498, § 780; p. 724, § 961 *a;* p. 751, § 999 *b.*

Will, The—*continued.*
the analogies in its effects with those of external and internal physical agents prove the distinct nature of mind, as do, also, perception and the passions, and are fatal to mental materialism, p. 85, § 175 *i;* p. 93–95, § 188½ *d;* p. 97, § 190 *a;* p. 104, § 215; p. 107–111, § 226–233½; p. 113, § 234 *c;* p. 124, 125, § 243–246; p. 282, § 451 *c;* p. 284, § 454; p. 288, § 459 *d, e;* p. 296, § 476 *c;* p. 313, § 487 *gg, h;* p. 314, § 488½; p. 323–332, § 500. See, below, *Its elective power, &c.*
a distinct element of the mind and instinctive principle, p. 97, § 190 *a;* p 296, § 476 *c;* p. 326, § 500 *n;* p. 357, § 526 *d;* p. 369, § 563, and *ibid.*
a stimulus to the brain, like the nervous power to that and to other parts, p. 124, § 244; p. 282, § 451 *c;* p. 288, § 459 *d, e;* p. 296, § 476 *c;* p. 326, 327, 328, § 500 *h, k.* See, also, NERVOUS POWER.
being shown to prove the distinct nature of mind, and its possession of special attributes or properties, I thus prove, also, by the analogies between the mental properties and the properties of life, the distinct nature of a Vital Principle with its several properties as its elements; *as above and below,* and p. 83, 84, § 175, VITAL PROPERTIES, and INSTINCT.
its modus operandi, p. 125, § 245; p. 296, § 476 *c;* p. 324–328, § 500 *d–l;* p. 357, § 526 *d.*
controls other properties of the mind, and the passions, p. 88, § 184 *b;* p. 124, § 243.
its elective power in animal life analogous to that of the passions and physical agents in organic life, p. 110, 111, § 233, 233¾; p. 113, § 234; p. 125, § 245, 246; p. 327, 328, § 500 *k.*
its philosophy in developing voluntary motion the same as when motion is developed by the nervous power in organic life, whether physical agents or the passions be the remote causes in the latter case, p. 111, § 233¾; p. 114, § 234 *e;* p. 125, § 245, 246; p. 281, 282, § 451 *a;* p. 296, § 476 *c;* p 324–328, § 500 *d–l.*

WORMS,
how they produce convulsions, p. 356–358, § 526 *d.*

WOUNDS,
their union by the *first intention* depends upon inflammatory action, p. 471, 472, § 732 *d–f.*
union of, has close analogies in the regenerative and reparative processes of animals and plants, and the differences of the latter reconciled with the inflammatory nature of the former, p. 474, 475, § 733 *f–h.* See, also, PLANTS.
do not heal uniformly where several tissues are involved, as in the stumps of amputated limbs, on account of their difference of organization and vital constitution, p. 61, § 132–134; p. 64, § 138–141; p. 67, § 149; p. 69, § 158; p. 70, § 162, *table* 1; p. 73, § 163.

Y.

YOUTH,
its relations to childhood, p. 376, § 578 *a, b.*
its prominent characteristic, the full development of the organs of generation, p. 377, § 578 *b.*
distinguished by many physiological changes, and corresponding susceptibilities to morbific and remedial agents, p. 27, § 52; p. 68–70, § 153–160; p. 412, § 686 *d;* p. 377–380, § 578 *c, d.*
the period of the institution of the menses, and of the secretion of semen; the latter shows by analogy, as to object and time, that the former is a secreted product, while its object and time of institution show that it has no general relation to organic life, and that, contrary to the prevailing belief, its suspension, *per se*, is of little moment in morbid conditions, p. 233, 234, § 428–432; p. 377–380, § 578 *c, d.*
distinguished by changes in the moral emotions which correspond with the vital developments, p. 380, § 578 *d.*
the coincident changes in the moral and physiological constitution, at this and other periods of life, illustrate, each by itself and by analogy, the mutability of the vital and intellectual properties, p. 68, 69, § 153–159; p. 374, § 576 *b–d;* p. 375, 376, § 577 *b–d;* p. 380, § 578 *d;* p. 381, § 579 *b.* See, also, VITAL PROPERTIES, *their mutability*, &c., OVUM, and PLANTS.
the period of life when the development of special functions displays the constitution of the nervous power, the natural office of this power in the organic and animal economy, its indirect and unceasing development and reflection upon every part of the being by the organic progress of the generative organs, in the fulfillment of its natural offices and as a morbific and curative agent, its direct excitement by mental emotions and passions, and how the principle of life is a bond of union between the corporeal and the intellectual part; *ibid*, and NERVOUS POWER, MORAL EMOTIONS, ANALOGIES, and p. 284–292, § 454–470; **P. 361, 362, § 530.**
offers problems to chemical physiology, p. 377, 379, § 578 *c, d.* See, also, PROBLEMS.

Z.

ZINC, SULPHATE OF,
its uses and special influences as an emetic and astringent, p. 547–549, § 863 *d;* p. 553, § 870 *a;* p. 571, § 890 *b;* p. 577, 578, § 890 *o;* p. 582, § 890½ *h;* p. 63, § 137 *d;* p. 65, § 143 *c;* p. 67, § 150, 151; p. 365–368, § 549–558; p. 566–568, § 889 *k, l;* p. 582, § 890½ *g.*

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